EXHIBIT A

EXHIBIT 111

Exhibit 111
to Verizon's Preliminary Disclosure of Asserted Claims and Infringement Contentions (P.R. 3-1)
U.S. Patent No. 8,121,111

INFRINGEMENT CHART FOR CLAIMS 1, 4-6, 8-12, 14-16, and 18-33[1]

Verizon Business Network Services, Inc., Cellco Partnership d/b/a Verizon Wireless, Verizon Data Services LLC, Verizon Business Global, LLC, Verizon Services Corp., and Verizon Patent and Licensing Inc. ("Verizon") contends that at least the following products (collectively, "Accused Products") infringe the claims of U.S. Patent No. 8,121,111 ("the '111 patent"):

- Huawei's optical network equipment that implements both the G.709 standard, set forth in Rec. ITU-T G.709/Y.1331 (hereinafter "G.709 Standard"), and a synchronization protocol relying on the IEEE-1588 V2 standard, set forth in IEEE-1588-2008 (hereinafter "IEEE-1588 Standard"), including but not limited to OptiX OSN series Multiple-Service OTN Platforms, e.g.:
    - OSN 1800 Series,
    - OSN 3800/6800 /8800 Series,
    - OSN 9800 Series,
    - OSN 500 /550 /580 Series,
    - OSN 1500 Series,
    - OSN 3500 Series,
    - OSN 7500 / 7500 II Series,
    - OSN 9560 Series (https://www.router-switch.com/huawei-transmission-network-price.html, last accessed 03/25/2020.)

As described herein, the claims of the '111 patent are not required to implement any mandatory or optional disclosures in the G.709 standard or in the IEEE-1588 V2 standard, as used individually. Products that are compliant with the G.709 standard can be, and are, implemented and used without infringing on the techniques in the '111 patent. Similarly, products that are compliant with the IEEE-1588 V2 standard can be, and are, implemented and used without infringing on the techniques in the '111 patent. The combination of techniques claimed in the '111 patent is not required or even set forth as optional by either standard. Huawei elected to use these two standards together, in an infringing way. Huawei's voluntary decision to employ these standards in an infringing manner is the basis for Verizon's infringement contentions.

Users of the Accused Products described above, the Accused Products themselves, and/or components incorporating the Accused Products directly infringe the claims as shown in the chart below. In addition, Huawei contributes to the infringement of the '111 patent because it provides the

[1] The infringement contentions provided herein are based on information obtained to date and may not be exhaustive. Verizon's investigation of Huawei's infringement is ongoing. Verizon reserves the right to supplement and/or amend these disclosures to identify additional Asserted Claims (P.R. 3-1(a)), to identify additional Accused Instrumentalities (P.R. 3-1(b)), and to further identify where each element of each Asserted Claim is found in each Accused Instrumentality (P.R. 3-1(c)), including on the basis of discovery obtained from Huawei and third-parties during the course of this litigation.

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Accused Products—a material part of the invention—to its end users, customers, partners, integrators, and resellers knowing the Accused Products are especially adapted for use in infringement. Moreover, on information and belief, Huawei, with the specific intent to induce infringement, publishes product manuals, marketing material, and other advertising touting the features of the Accused Products and provides instructions and technical support to users, which encourages and instructs them how to use the Accused Products in an infringing manner—inducing these third parties to infringe the '111 Patent.

Based on Verizon's investigation to date, Verizon alleges that each element of the asserted claims is found literally in the Accused Products and/or methods that use the Accused Products (the "Accused Instrumentalities") as shown in the chart below. To the extent that one or more elements of the asserted claims are not literally present in the Accused Instrumentalities, Verizon alleges that the Accused Instrumentalities infringe under the doctrine of equivalents.

This disclosure is preliminary. Verizon's discovery and investigation in connection with this action is ongoing. Verizon has not received all documents that may be relevant to this disclosure, and Huawei has not yet produced any relevant information and documents. Verizon therefore reserves the right to rely on documents, discovery responses, and testimony collected during the discovery process. Verizon also reserves the right to add to, subtract from, or otherwise amend this disclosure as discovery proceeds. In addition, the Court has not yet construed any of the terms within the asserted claims shown below. Verizon reserves the right to amend this disclosure pursuant to P.R. 3-6 after the Court's claim construction ruling, if appropriate.

Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found**[2]
Claim 1[3]	
[1.pre] A method, comprising: [4]	Verizon contends that the preamble is not limiting. Nonetheless, the Accused Products perform a method.

[2] The Accused Instrumentalities and associated exhibits discussed and/or cited for any claim herein are representative in all material respects of all other Accused Instrumentalities identified for that claim (e.g., although various servers may have immaterial differences in their hardware, firmware, and/or software configuration, the cited references are believed to be illustrative of all such accused server models).

[3] All infringement contentions set forth herein for any independent patent claims are hereby incorporated by reference into the infringement contentions alleged for any dependent patent claims that depend on such independent claims, as if fully set forth therein.

[4] Verizon's inclusion of any claim preamble in this claim chart should not be interpreted as an admission that the preamble is limiting. Verizon reserves the right to take the position that the claim preambles are limiting or not limiting on a claim-by-claim basis.

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For example, the Accused Products practice a method for synchronizing a clock or the time by implementing portions of the G.709 Standard and the IEEE-1588 Standard over G.709 interfaces.

As one example, the OSN 1800 Series products support both the G.709 and the IEEE-1588 standards and protocols:

OTN-Side	Interface Type	OTU-1/OTU-2 (ITU-T G.709)
	Fiber Type	SMF (ITU-T G.652)/ DSF (ITU-T G.653)
	Plug	SFP/XFP
Topology		Point to point, chain, star, ring
Synchronization		2Mbit/s or 2MHz, SSM supported Ethernet Syn, 1588V2

See OptiX OSN 1800 series datasheet, *available at* http://www1.huawei.com/ucmf/groups/public/documents/webasset/hw_u_387741.pdf (last accessed April 28, 2020).

As another example, the OSN 8800 Series products support the same standards and protocols:

OTN service	OTU1, OTU2, OTU2e, OTU3	ITU-T G.709 ITU-T G.959.1

3.9 Clock Feature

OptiX OSN 8800 T32 and OptiX OSN 8800 T64 support the physical layer clock and PTP clock to realize the synchronization of the clock and the time.

The physical clock extracts the clock from the serial bit stream at the physical layer to realize the synchronization of the frequency.

The Precision Time Protocol (PTP) clock complies with the IEEE 1588 v2 protocol. IEEE 1588 v2 is a synchronization protocol, which realizes time synchronization based on the timestamp generated during the exchanging of protocol packets. It provides the nanosecond accuracy to meet the requirements of 3G base stations.

See OptiX OSN 8800 Product Overview, *available at* https://www.actfornet.com/HUAWEI_TRANSPORT_DOCS/OptiX%20OSN%208800%20T16%20Product%20Overview.pdf

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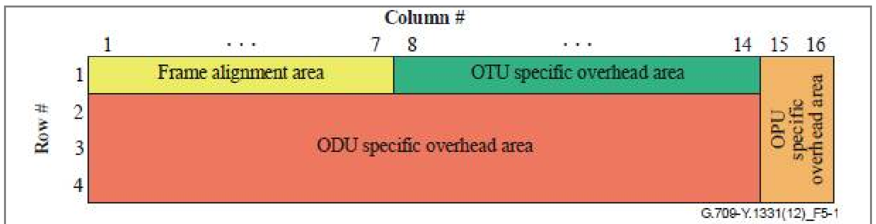
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	(last accessed April 28, 2020). The G.709 standard defines an information structure for optical transport network (OTN) interfaces. The information structure includes various sublayers called the ***optical channel transport unit (OTU)***, the ***optical channel data unit (ODU)***, and the ***optical channel payload unit (OPU)***. G.709 Standard at p. 9. The assignment of the overhead (OH) of the optical transport/data/payload unit is defined below: **OTUk, OTUCn, ODUk, ODUCn, OPUk and OPUCn overhead assignment**: The assignment of an overhead in the optical transport/data/payload unit signal to each part is defined in Figure 5-1. OTUk, ODUk, OPUk contain one instance of OTU, ODU, OPU overhead. OTUCn, ODUCn and OPUCn contain n instances of OTU, ODU, OPU overhead, numbered 1 to n. Interleaved versions of the OTU, ODU and OPU overhead may be present on OTUCn interfaces. This interleaving is interface specific and specified for OTN interfaces with standardized application codes in the interface specific Recommendations (ITU-T G.709.x series). Within the other clauses of this Recommendation an OTUCn, ODUCn and OPUCn are presented in an interface independent manner, by means of n OTUC, ODUC and OPUC instances that are marked #1 to #n.  **Figure 5-1 – OTU, ODU and OPU overhead** *Id.* The Accused Products practice the method at least by sending and receiving Precision Time Protocol (PTP) messages using the OTN synchronization messaging channel (OSMC) within the "OTU overhead."

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	See below

11.1 OTUk frame structure

The OTUk (k = 1,2,3,4) frame structure is based on the ODUk frame structure and extends it with a forward error correction (FEC) as shown in Figure 11-1. 256 columns are added to the ODUk frame for the FEC and the reserved overhead bytes in row 1, columns 8 to 14 of the ODUk overhead are used for an OTUk specific overhead, resulting in an octet-based block frame structure with four rows and 4080 columns. The MSB in each octet is bit 1, the LSB is bit 8.

NOTE – This Recommendation does not specify an OTUk frame structure for k=0, k=2e or k=flex. See Annex G for the specification of OTU0LL.

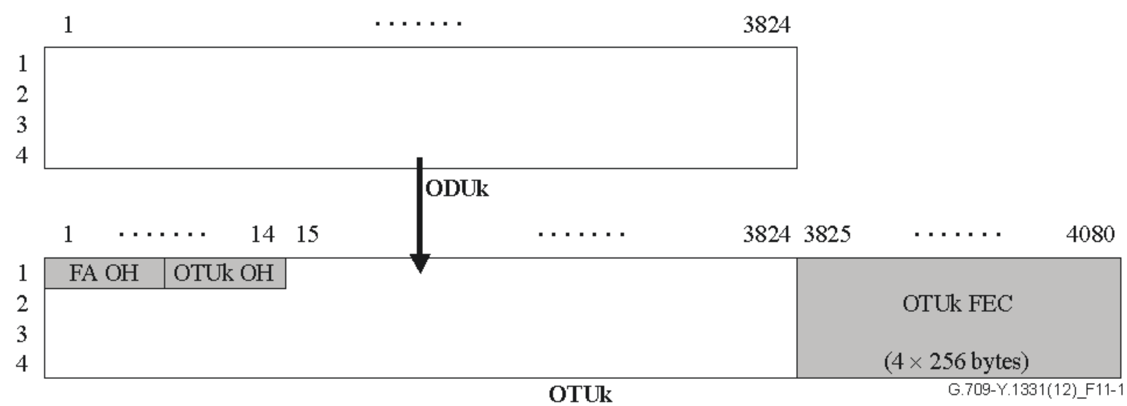

Figure 11-1 – OTUk frame structure

Id. at p. 32.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	15.1.3 Optical transport unit overhead (OTU OH) OTU OH information is part of the OTU signal structure. It includes information for operational functions to support the transport via one or more OCh connections. The OTU OH is terminated where the OTU signal is assembled and disassembled. The specific OH format and coding is defined in clauses 15.6 and 15.7. The specific frame structure and coding for the non-standard OTUkV OH is outside the scope of this Recommendation. Only the required basic functionality that has to be supported is defined in clause 15.7.3. *Id.* at p. 44. The Precision Time Protocol (PTP) is used to send and receive messages between nodes of the OTN and synchronize nodes as defined in the IEEE-1588 Standard. *See e.g.*: **6. Clock synchronization model** **6.1 General** This clause provides a model for understanding the operation of the Precision Time Protocol. The exact specifications of these interactions are found in subsequent clauses. The PTP standard specifies a clock synchronization protocol. This protocol is applicable to distributed systems consisting of one or more nodes, communicating over a network. Nodes are modeled as containing a real-time clock that may be used by applications within the node for various purposes such as generating timestamps for data or ordering events managed by the node. The protocol provides a mechanism for synchronizing the clocks of participating nodes to a high degree of accuracy and precision. This standard specifies: a) The Precision Time Protocol b) The node, system, and communication properties necessary to support PTP. IEEE-1588 Standard at p. 16. In addition to sending and receiving PTP messages in the OTU overhead, the Accused Products also send and receive other

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	signals, such as the ODU PM delay measurement (DMp) signal within the ODU overhead. *See e.g.*: **15.8.2.1.6 ODU PM delay measurement (DMp)** For ODU path monitoring, a one-bit path delay measurement (DMp) signal is defined to convey the start of the delay measurement test. The ODUk and ODUCn contain one instance of ODU PM DMp overhead. The DMp signal consists of a constant value (0 or 1) that is inverted at the beginning of a two-way delay measurement test. The transition from 0→1 in the sequence …0000011111…, or the transition from 1→0 in the sequence …1111100000… represents the path delay measurement start point. The new value of the DMp signal is maintained until the start of the next delay measurement test. This DMp signal is inserted by the DMp originating P-CMEP and sent to the far-end P-CMEP. This far-end P-CMEP loops back the DMp signal towards the originating P-CMEP. The originating P-CMEP measures the number of frame periods between the moment the DMp signal value is inverted and the moment this inverted DMp signal value is received back from the far-end P-CMEP. The receiver should apply a persistency check on the received DMp signal to be tolerant for bit errors emulating the start of delay measurement indication. The additional frames that are used for such persistency checking should not be added to the delay frame count. The looping P-CMEP should loop back each received DMp bit within approximately 100 µs. Refer to [ITU-T G.798] for the specific path delay measurement process specifications. NOTE 1 – Path delay measurements can be performed on-demand, to provide the momentary two-way transfer delay status, and pro-active, to provide 15-minute and 24-hour two-way transfer delay performance management snapshots. NOTE 2 – Equipment designed according to the 2008 or earlier versions of this Recommendation may not be capable of supporting this path delay monitoring. For such equipment, the DMp bit is a bit reserved for future international standardization and set to zero. NOTE 3 – This process measures a round trip delay. The one way delay may not be half of the round trip delay in the case where the transmit and receive directions of the ODU network connection are of unequal lengths (e.g., in networks deploying unidirectional protection switching). G.709 Standard at pp. 60-61.
[1.a] receiving a first time stamp associated with a	At least by sending and receiving PTP messages within the OTU overhead (*e.g.*, PTP event messages such as a Delay Request), the Accused Products receive a first time stamp associated with a first location (*e.g.*, a slave clock at a first node) at a second location (*e.g.*, a master clock at a second node).

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
first location at a second location,	The OSMC in the OTU overhead is an optional feature within G.709 defined as a channel for transporting (time-stamped) PTP messages. *See e.g.*: **OTN synchronisation message channel (OSMC)** For synchronisation purposes, the OSC OSMC signal is defined as an OTN synchronisation message channel to transport SSM and PTP messages. NOTE 1 – Support of OSC OSMC in a MOTUm interface is optional. NOTE 2 – Equipment designed prior to Edition 4.6 of this recommendation may not be able to support OSC OSMC. G. 709 Standard at p. 39. **15.7.2.4 OTU OTN synchronisation message channel (OSMC)** For synchronisation purposes, one byte is defined in the OTU overhead as an OTN synchronisation message channel to transport SSM and PTP messages within SOTU and MOTU interfaces. The OSMC bandwidth is listed in Table 15-3. The OTUk and OTUCn contain one instance of OTU OSMC overhead. NOTE 1 – OTU OSMC is not defined for MOTUm and SOTUm interfaces. NOTE 2 – Support of OTU OSMC in a SOTU or MOTU interface is optional. NOTE 3 – Equipment designed prior to Edition 5.0 of this Recommendation may not be able to support OTU OSMC via their SOTU or MOTU interfaces. NOTE 4 – SOTU and MOTU interfaces with vendor specific application identifiers may support an OSMC function. The encapsulation of the messages and overhead location are then vendor specific. *Id.* at pp. 54-55.

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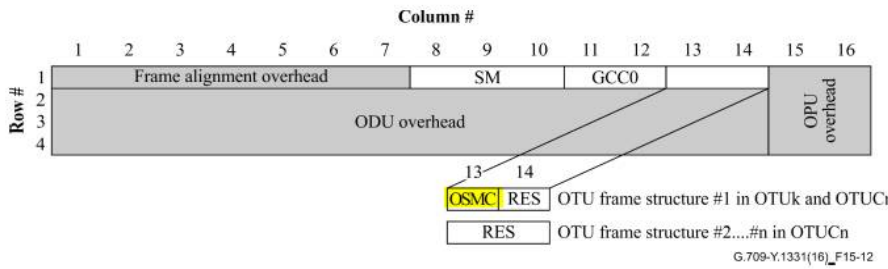
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	15.7.1 OTU overhead location The OTU overhead location is shown in Figures 15-12 and 15-13. The OTUk contains one instance of OTU overhead. The OTUCn contains n instances of OTU overhead, numbered 1 to n (OTU OH #1 to OTU OH #n).  **Figure 15-12 – OTU overhead** *Id.* at p. 50. The PTP messages transported by the OSMC are further defined in the IEEE-1588 Standard which defines the Precision Time Protocol. *See e.g.*:

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	6. Clock synchronization model **6.1 General** This clause provides a model for understanding the operation of the Precision Time Protocol. The exact specifications of these interactions are found in subsequent clauses. The PTP standard specifies a clock synchronization protocol. This protocol is applicable to distributed systems consisting of one or more nodes, communicating over a network. Nodes are modeled as containing a real-time clock that may be used by applications within the node for various purposes such as generating timestamps for data or ordering events managed by the node. The protocol provides a mechanism for synchronizing the clocks of participating nodes to a high degree of accuracy and precision. This standard specifies: a) The Precision Time Protocol b) The node, system, and communication properties necessary to support PTP. IEEE-1588 Standard at p. 16. **6.4 PTP message classes** The protocol defines event and general PTP messages. Event messages are timed messages in that an accurate timestamp is generated at both transmission and receipt as specified in 6.6.5. General messages do not require accurate timestamps. *Id.* at p. 17.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	6.5 PTP device types **6.5.1 General** There are five basic types of PTP devices, as follows: a) Ordinary clock b) Boundary clock c) End-to-end transparent clock d) Peer-to-peer transparent clock e) Management node All five types implement one or more aspects of the protocol. *Id.* at p. 18. One type of PTP messages, the PTP *event* messages, are timestamped on egress from an OTN node, and transmitted within the OTU Overhead to another OTN node in the network via the OSMC. *See, e.g.*:

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	15.7.2.4.1 Generation of event message timestamps **15.7.2.4.1.1 SOTU and MOTU interface event message timestamp point** The SOTU and MOTU interface message timestamp point [ITU-T G.8260] for a PTP event message transported over the OSMC shall be the X-frame multiframe event preceding the beginning of the GFP frame in which the PTP event message is carried. See Figure 15-16. Since the GFP frames may be longer than X-4 bytes, a frame may cross the X-frame multiframe boundary. The X-frame multiframe contains frames numbered 0, 1, .., X-1. **15.7.2.4.1.2 Event timestamp generation** All PTP event messages are timestamped on egress and ingress SOTU and MOTU interfaces. The timestamp shall be the time at which the event message timestamp point passes the reference plane [ITU-T G.8260] marking the boundary between the PTP node (i.e., OTN node) and the network. G.709 Standard at p. 55.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	OTUCn For further study. NOTE 3 – This time synchronization over SOTU and MOTU interface implementation does not generate event message timestamps using a point other than the message timestamp point [ITU-T G.8260]. In this time synchronization over SOTU and MOTU interface implementation, the timestamps are generated at a point removed from the reference plane. Furthermore, the time offset from the reference plane is likely to be different for inbound and outbound event messages. To meet the requirement of this subclause, the generated timestamps should be corrected for these offsets. Figure 19 in [b-IEEE 1588] illustrates these offsets. Based on this model, the appropriate corrections are as follows: <egressTimestamp> = <egressMeasuredTimestamp> + egressLatency <ingressTimestamp> = <ingressMeasuredTimestamp> − ingressLatency where the actual timestamps <egressTimestamp> and <ingressTimestamp> measured at the reference plane are computed from the detected, i.e., measured, timestamps by their respective latencies. Failure to make these corrections results in a time offset between the slave and master clocks. *Id.* at p. 56. Because PTP event messages are time stamped, they are used to measure propagation delay between nodes (*e.g.*, between a slave clock at a first node and a master clock at a second node). *See e.g.*:

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	Two mechanisms are used in PTP to measure the propagation delay between PTP ports. The first one, the delay request-response mechanism, uses the messages Sync, Delay_Req, Delay_Resp, and if required, Follow_Up; see 11.3. The second one, the peer delay mechanism, uses the messages Pdelay_Req, Pdelay_Resp, and if required, Pdelay_Resp_Follow_Up; see 11.4. Ports on ordinary and boundary clocks can be implemented using either mechanism. Ports on end-to-end transparent clocks are independent of these mechanisms. Ports on peer-to-peer transparent clocks use the peer delay mechanism. These two mechanisms do not interwork on the same communication path. In addition, the peer delay mechanism is restricted to topologies where each peer-to-peer port communicates PTP messages with at most one other such port; see 11.4.4. The use of the various clock types is limited as follows: — Ordinary and boundary clocks with ports implementing the peer delay mechanism, and peer-to-peer transparent clocks, can only be connected in topologies where ports implementing the peer delay mechanism communicate PTP messages to and from a single port also implementing the peer delay mechanism; see 11.4.4. Except in carefully designed networks, this will preclude the use of end-to-end transparent clocks and bridges that do not support PTP using the peer delay mechanism, e.g., a conventional bridge. — Ordinary and boundary clock ports implementing the delay request-response mechanism, and end-to-end transparent clocks, can be connected in any topology that excludes ports using the peer delay mechanism. This precludes the use of peer-to-peer transparent clocks in such a system. — A boundary clock with ports supporting each of the two mechanisms may be used to bridge between regions supporting the different mechanisms. IEEE-1588 Standard at p. 19. The timestamping of the PTP event message is based on the value of a local clock at the egress node. *See id.*

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	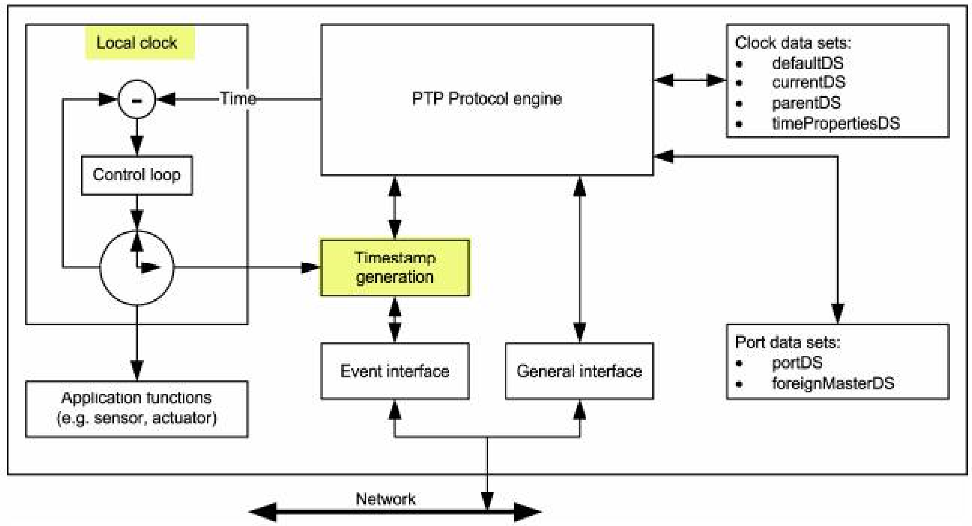 **Figure 2—Model of an ordinary clock** An ordinary clock communicates with the network via two logical interfaces based on a single physical port. The event interface is used to send and receive event messages, which are timestamped by the timestamp generation block based on the value of the local clock. The general interface is used to send and *Id.*

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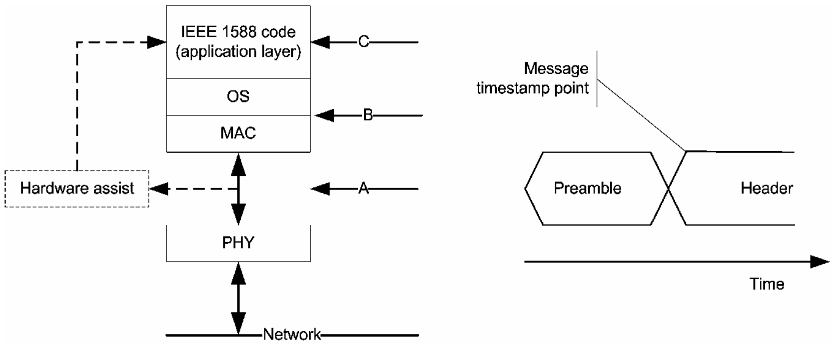
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	6.6.5 Generation of message timestamps A timestamp event is generated at the time of transmission and reception of any event message. The timestamp event occurs when the message's timestamp point crosses the boundary between the node and the network. The generation of the timestamps, indicated in Figure 12 and Figure 13, is modeled in Figure 14.  **Figure 14—Timestamp generation model** PTP timing messages are issued from the PTP application code in one clock and received and processed by the PTP application code in another clock. These messages typically have a preamble specified by the physical layer of the communication protocol in use on the network. The preamble is followed by one or more protocol specific headers and then user data such as the PTP payload. For every such transport mechanism, this standard specifies a particular point in PTP timing messages, often the start of frame signal, as a distinguished point termed the message timestamp point. As a PTP message traverses the protocol stack in a node, the timestamps are generated when the message timestamp point passes a defined point in the stack. This point may be in the application layer, illustrated by "C" in Figure 14, in the kernel *Id.* at p. 36.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]

7.3.4.2 Event timestamp generation

All PTP event messages are timestamped on egress and ingress. The timestamp shall be the time at which the event message timestamp point passes the reference plane marking the boundary between the PTP node and the network.

NOTE 1—If an implementation generates event message timestamps using a point other than the message timestamp point, then the generated timestamps should be appropriately corrected by the time interval between the actual time of detection and the time the message timestamp point passed the reference plane. Failure to make these corrections results in a time offset between the slave and master clocks.

NOTE 2—In general the timestamps may be generated at a point removed from the reference plane. Furthermore, the time offset from the reference plane is likely to be different for inbound and outbound event messages. To meet the requirement of this subclause, the generated timestamps should be corrected for these offsets. Figure 19 illustrates these offsets. Based on this model, the appropriate corrections are as follows:

<egressTimestamp> = <egressMeasuredTimestamp> + egressLatency
<ingressTimestamp> = <ingressMeasuredTimestamp> — ingressLatency

where the actual timestamps <egressTimestamp> and <ingressTimestamp> measured at the reference plane are computed from the detected, i.e., measured, timestamps by their respective latencies. Failure to make these corrections results in a time offset between the slave and master clocks.

Id. at p. 44.

The Accused Products support a "single step" PTP mode where the "actual transmit timestamp is added to the packet to be transmitted".

Single/Double Step Mode	Single Step, Double Step	Specifies whether an IEEE 1588 port works in the single or double step mode. • In the single step mode, the actual transmit timestamp is added to the packet to be transmitted. This requires the equipment of higher precision and accuracy. • In the double step mode, the actual transmit timestamp is not added to the packet to be transmitted. Instead, followup packets are used.

See "OptiX OSN 9560 Intelligent Optical Switching System Feature Description," *available at*

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	https://support.huawei.com/enterprise/en/doc/EDOC0100589340?section=j00c (hereinafter "Huawei Feature Description"), at Table 9-3. Single step clocks and/or two-step clocks are disclosed in the IEEE-1588 Standard. *See e.g.*: **9.5.9.3 One-step clocks** The originTimestamp field of the Sync message shall be an estimate no worse than ±1 s of the <syncEventEgressTimestamp> excluding any fractional nanoseconds. The originTimestamp field of the Sync message should be the <syncEventEgressTimestamp> excluding any fractional nanoseconds. The sum of the Sync message correctionField and originTimestamp field shall be the value of the <syncEventEgressTimestamp> including any fractional nanoseconds. **9.5.9.4 Two-step clocks** The originTimestamp field of the Sync message shall be 0 or an estimate no worse than ±1 s of the <syncEventEgressTimestamp>. The correctionField of the Sync message shall be set to 0. A two-step clock shall transmit both a Sync and a Follow_Up message. The port shall capture the sequenceId value of the Sync message as an input to the sequenceId field of the Follow_Up message. The mechanism for obtaining the value for the preciseOriginTimestamp and correctionField fields of the associated Follow_Up message shall be started. IEEE-1588 Standard at p. 104. The Accused Products use at least one PTP path delay measurement mechanism: delay request-response mechanism, or peer-delay mechanism. *See e.g.*:

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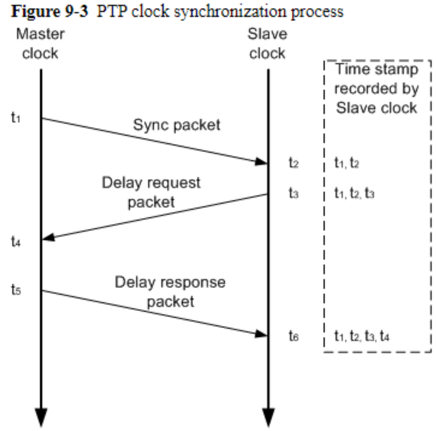
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	7.5.4 Path delay measurement mechanism There are two mechanisms for measuring the propagation time of an event message. These mechanisms are as follows: — Delay request-response mechanism (see 11.3), which measures the propagation time between two stateful PTP ports — Peer delay mechanism (see 11.4), which measures the propagation time between two ports supporting the peer delay mechanism NOTE—The peer delay mechanism may be supported on both stateful and stateless PTP ports. *Id.* at p. 52. The Accused Products implementing the PTP protocol receive a first time stamp associated with a first location at a second location. *See, e.g.*: **PTP Clock Synchronization Mechanism** The PTP protocol is based on the most accurate match time at which synchronous data packets are propagated and received. Each slave clock is synchronized with the master clock by exchanging the synchronous packets with the master clock. The PTP clock synchronization process is shown in Figure 9-3. **Figure 9-3** PTP clock synchronization process 

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	Huawei Feature Description at § 9.4.3. In a basic PTP synchronization message exchange clocks synchronize by exchanging PTP timing messages. *See e.g.*: **6.6.3 Synchronizing ordinary and boundary clocks** In a PTP system, ordinary or boundary clocks synchronize by exchanging PTP timing messages on the communication path linking the two clocks. For example, in Figure 10, boundary clock-1 synchronizes to ordinary clock-1 by exchanging messages on communication path-1. The basic pattern of synchronization message exchange is illustrated in Figure 12. IEEE-1588 Standard at p. 32.

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	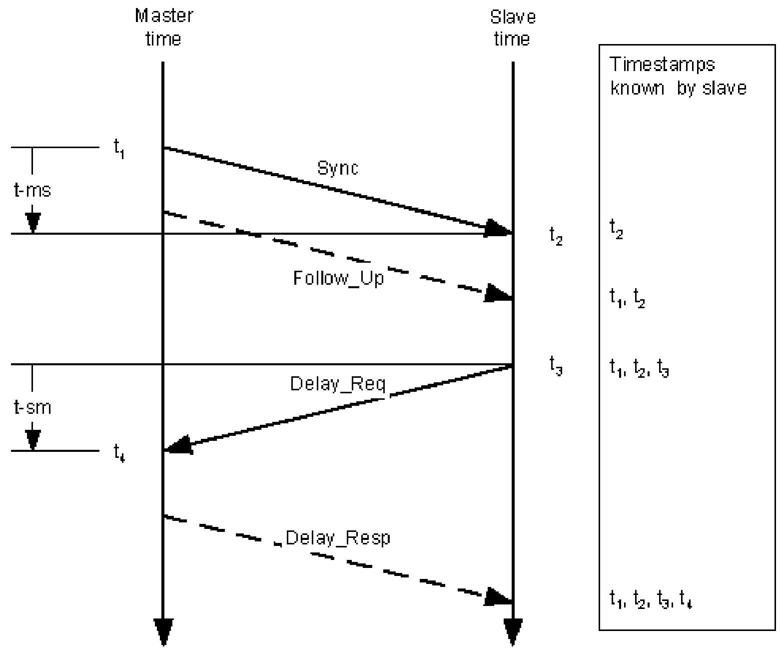 **Figure 12—Basic synchronization message exchange**

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	The message exchange pattern is as follows: a) The master sends a Sync message to the slave and notes the time t_1 at which it was sent. b) The slave receives the Sync message and notes the time of reception t_2. c) The master conveys to the slave the timestamp t_1 by: 1) Embedding the timestamp t_1 in the Sync message. This requires some sort of hardware processing for highest accuracy and precision. 2) Embedding the timestamp t_1 in a Follow_Up message. d) The slave sends a Delay_Req message to the master and notes the time t_3 at which it was sent. e) The master receives the Delay_Req message and notes the time of reception t_4. f) The master conveys to the slave the timestamp t_4 by embedding it in a Delay_Resp message. At the conclusion of this exchange of messages, the slave possesses all four timestamps. These timestamps may be used to compute the offset of the slave's clock with respect to the master and the mean propagation time of messages between the two clocks, which in Figure 12 is the mean of t-ms and t-sm. *Id.* at p. 34. For example, with the PTP delay request-response mechanism, the first location may be the OTN node hosting the slave clock, and the first time stamp associated with the first location may be the timestamp for the "Delay_Req" (*i.e.*, Delay Request) PTP event message originated from the OTN node hosting the slave clock. *See e.g.*

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	11.3 Delay request-response mechanism **11.3.1 Delay request-response mechanism general requirements** The delay request-response mechanism measures the <meanPathDelay> between a pair of PTP ports, each of which supports the state machine of 9.2.5. The delay request-response mechanism uses the messages Sync, Delay_Req, Delay_Resp and possibly Follow_Up as shown in the timing diagram of Figure 34. This mechanism shall be executed independently in each supported domain of the two clocks. The timestamps t_1 and t_2 for the Sync message and t_3 and t_4 for the Delay_Req message of Figure 34 shall be measured as defined in 7.3.4.2. Timestamps t_1 and t_4 shall be measured using the time of the master node, and the timestamps t_2 and t_3 shall be measured using the time of the slave node. If the delayAsymmetry (see 7.4.2) of the paths connected to the ingress and egress ports is known, the corrections of 11.6 shall be implemented. NOTE—The nominal value of the <meanPathDelay> is computed as <meanPathDelay> = $[(t_2 - t_1) + (t_4 - t_3)]/2 = [(t_2 - t_3) + (t_4 - t_1)]/2$. *Id.* at p. 110.

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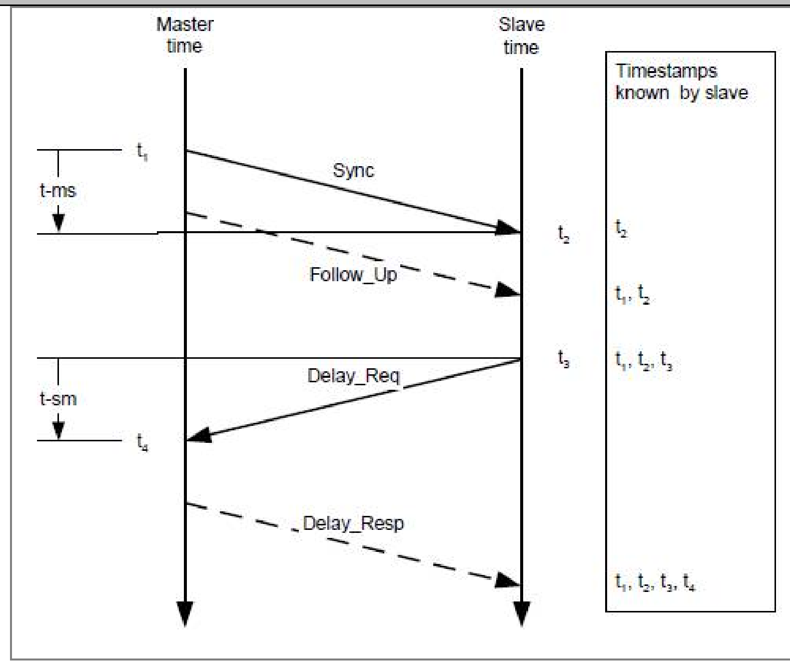
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	 *Id.* at pp. 34, 110.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	11.3.2 Delay request-response mechanism operational specifications The actual value of the <meanPathDelay> shall be measured and computed as follows for each instance of a delay request-response measurement: a) The master node prepares and issues a Sync message per 9.5.9. If the node is a two-step clock, it also prepares and issues a Follow_Up message per 9.5.9.4. b) The slave node shall: 1) Upon receipt of the Sync message from the master generate timestamp t_2. 2) If asymmetry corrections are required, modify the correctionField of the received Sync message per 11.6.2. 3) If required to send a Delay_Req message based on the timing requirements of subclause 9.5.11.2: i) Prepare a Delay_Req message with the correctionField (see 13.3.2.7) set to 0. The originTimestamp shall be set to 0 or an estimate no worse than ±1 s of the egress time of the Delay_Req message. ii) If asymmetry corrections are required, modify the correctionField per 11.6.3. iii) Send the Delay_Req message and generate and save timestamp t_3. c) Upon receipt of the Delay_Req message, the master node shall : 1) Generate timestamp t_4 2) Prepare a Delay_Resp message 3) Copy the sequenceId field from the Delay_Req message to the sequenceId field of the Delay_Resp message 4) Copy the sourcePortIdentity field from the Delay_Req message to the requestingPortIdentity field of the Delay_Resp message 5) Copy the domainNumber field from the Delay_Req message to the domainNumber field of the Delay_Resp message 6) Set the correctionField of the Delay_Resp message to 0 7) Add the correctionField of the Delay_Req message to the correctionField of the Delay_Resp message 8) Set the receiveTimestamp field of the Delay_Resp message to the seconds and nanoseconds portion of the time t_4 9) Subtract any fractional nanosecond portion of t_4 from the correctionField of the Delay_Resp message 10) Issue the Delay_Resp message

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	d) Upon receipt of the Delay_Resp message by the slave: 1) If the received Sync message indicated that a Follow_Up message will not be received, the <meanPathDelay> shall be computed as: <meanPathDelay> = [(t_2 - t_3) + (receiveTimestamp of Delay_Resp message – originTimestamp of Sync message) – correctionField of Sync message – correctionField of Delay_Resp message]/2. 2) If the received Sync message indicated that a Follow_Up message will be received, the <meanPathDelay> shall be computed as: <meanPathDelay> = [(t_2 - t_3) + (receiveTimestamp of Delay_Resp message – preciseOriginTimestamp of Follow_Up message) – correctionField of Sync message– correctionField of Follow_Up message – correctionField of Delay_Resp message]/2. NOTE— The delay request-response path length measurement normally uses the timestamps and correctionField of the most recent Sync and corresponding Follow_Up message prior to the Delay_Req message. However, the delay request-response measurement may use any Sync and corresponding Follow_Up message, although this will reduce the accuracy of the computed <meanPathDelay>. IEEE 1588 at 111-112. As another example, in the peer delay request-response mechanism, the first location may be a first OTN node sending out a delay request message, and the first time stamp associated with the first location may be the timestamp for the "Pdelay_Req" (*i.e.*, Peer Delay Request) PTP event message. *See e.g.*

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	11.4 Peer delay mechanism **11.4.1 Peer delay mechanism general requirements** The peer delay mechanism measures the port-to-port propagation time, i.e., the link delay, between two communicating ports supporting the peer delay mechanism. This measurement should be made on all ports of a device including those that are blocked by lower level protocols. The addressing or other mechanisms to support this requirement are network specific and are specified in the relevant annexes to this standard. The link delay measurement shall be made independently by each port implementing the peer delay mechanism. NOTE—This requirement means that the link delay is known by ports on both ends of a link. This allows path length corrections to be made immediately upon reconfiguration of the network. In ordinary and boundary clocks, the peer delay mechanism shall be independent of whether the port is a master or a slave. The peer delay mechanism uses the messages Pdelay_Req, Pdelay_Resp, and possibly Pdelay_Resp_Follow_Up, as shown in the timing diagram of Figure 35.

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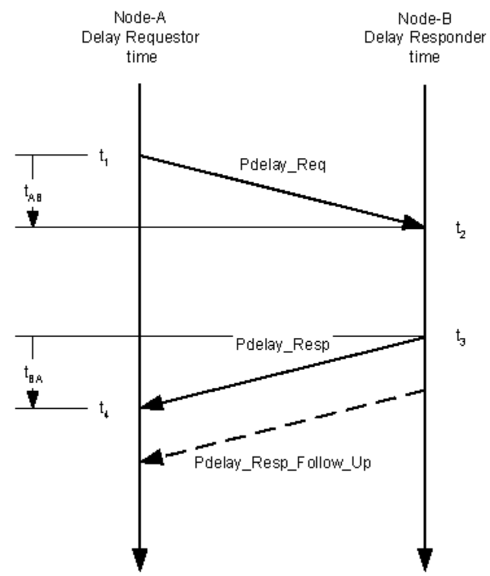
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	 **Figure 35—Peer delay link measurement** The timestamps t_1 and t_2 for the Pdelay_Req message and t_3 and t_4 for the Pdelay_Resp message of Figure 35 are measured as defined in 7.3.4. If the delayAsymmetry (see 7.4.2) of the links connected to the ingress and egress ports are known, the corrections of 11.6 shall be implemented. The timestamps t_1 and t_4 shall be measured by Node-A as follows: — If Node-A is a peer-to-peer transparent clock, the timescale used is specified in 10.1. — If Node-A is an ordinary or boundary clock, the timescale used is that of the domain of the clock. Timestamps t_2 and t_3 shall be measured by Node-B as follows: — If Node-B is a peer-to-peer transparent clock, the timescale used is specified in 10.1. — If Node-B is an ordinary or boundary clock, the timescale used is that of the domain of the clock. NOTE—The nominal value of the <meanPathDelay> is computed as <meanPathDelay> = $[(t_2 - t_1) + (t_4 - t_3)]/2 = [(t_2 - t_3) + (t_4 - t_1)]/2$. The actual value is specified in 11.4.3.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	Id. at pp. 112-113. **11.4.3 Peer delay mechanism operational specifications** The actual value of the meanPathDelay shall be measured and computed as follows for each instance of a peer delay request-response measurement: a) The delay requestor, Node-A: 1) Prepares a Pdelay_Req message. The correctionField (see 13.3.2.7) shall be set to 0. i) If Node-A is an ordinary or boundary clock, then the domainNumber field of the header shall be set to the domain of Node-A. ii) If Node-A is a syntonized peer-to-peer transparent clock, the domainNumber field of the header should be set to the domain being measured, either the primary syntonization domain, or one of the alternate domains if syntonization to multiple domains is implemented on Node-A. iii) If Node-A is not a syntonized peer-to-peer transparent clock, the domainNumber field of the header shall be set to 0. 2) If asymmetry corrections are required, shall modify the correctionField per 11.6.4. 3) Shall set the originTimestamp to 0 or an estimate no worse than ±1 s of the egress timestamp, t_1, of the Pdelay_Req message. 4) Shall send the Pdelay_Req message and generate and save timestamp t_1. b) If the delay responder, Node-B, is a one-step clock, it shall: 1) Generate timestamp t_2 upon receipt of the Pdelay_Req message 2) Prepare a Pdelay_Resp message 3) Copy the sequenceId field from the Pdelay_Req message to the sequenceId field of the Pdelay_Resp message 4) Copy the sourcePortIdentity field from the Pdelay_Req message to the requestingPortIdentity field of the Pdelay_Resp message 5) Copy the domainNumber field from the Pdelay_Req message to the domainNumber field of the Pdelay_Resp message 6) Copy the correctionField from the Pdelay_Req message to the correctionField of the Pdelay_Resp message 7) Then: i) Set to 0 the requestReceiptTimestamp field of the Pdelay_Resp message ii) Issue the Pdelay_Resp message and generate timestamp t_3 upon sending

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	Id. at p. 114. As shown above with respect to the delay request-response mechanism, the OTN node hosting the master clock receives a "Delay_Req" event message that includes an "originTimestamp" message field that includes a timestamp: **13.6 Sync and Delay_Req messages** **13.6.1 General Sync and Delay_Req message specifications** The fields of Sync and Delay_Req messages shall be as specified in Table 26. **Table 26—Sync and Delay_Req message fields** Bits: 7 6 5 4 3 2 1 0 — Octets — Offset header (see 13.3) — 34 — 0 originTimestamp — 10 — 34 **13.6.2 Sync and Delay_Req message field specifications** **13.6.2.1 originTimestamp (Timestamp)** The value of the originTimestamp field shall be as specified in 9.5.9 and 11.3. *Id.* at p. 130. The value of this "originTimestamp" is described in Sections 9.5.9 and 11.3 of the IEEE-1588 Standard. Likewise, in the peer delay request-response mechanism, the second OTN node receives a "Pdelay_Req" message which includes an "originTimestamp" message field that includes a timestamp:

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13.9 Pdelay_Req message

13.9.1 General Pdelay_Req message specifications

The fields of the Pdelay_Req message shall be as specified in Table 29.

Table 29—Pdelay_Req message fields

Bits								Octets	Offset
7	6	5	4	3	2	1	0		
header (see 13.3)								34	0
originTimestamp								10	34
reserved								10	44

NOTE—The reserved field in the Pdelay_Req message is to make the message length match the length of the Pdelay_Resp message. In some networks and bridges, messages with unequal lengths have different transit times that introduce asymmetry errors.

13.9.2 Pdelay_Req message field specifications

13.9.2.1 originTimestamp (Timestamp)

The value of the originTimestamp shall be as specified in 11.4.3.

Id. at p. 131.

The value of this "originTimestamp" is described in Section 11.4.3 of the IEEE-1588 Standard.

In addition, the header of the "Delay_Req" and "Pdelay_Req" messages includes a "correctionField," which is another timestamp used to correct for propagation delay. *See id.* at §§ 11.3.2, 11.6.3.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	11.3.2 Delay request-response mechanism operational specifications The actual value of the <meanPathDelay> shall be measured and computed as follows for each instance of a delay request-response measurement: a) The master node prepares and issues a Sync message per 9.5.9. If the node is a two-step clock, it also prepares and issues a Follow_Up message per 9.5.9.4. b) The slave node shall: 1) Upon receipt of the Sync message from the master generate timestamp t_2. 2) If asymmetry corrections are required, modify the correctionField of the received Sync message per 11.6.2. 3) If required to send a Delay_Req message based on the timing requirements of subclause 9.5.11.2: i) Prepare a Delay_Req message with the correctionField (see 13.3.2.7) set to 0. The originTimestamp shall be set to 0 or an estimate no worse than ±1 s of the egress time of the Delay_Req message. ii) If asymmetry corrections are required, modify the correctionField per 11.6.3. iii) Send the Delay_Req message and generate and save timestamp t_3. *Id.* at p. 111.

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13.3 Header

13.3.1 General header specifications

The common header for all PTP messages shall be as specified in Table 18.

Table 18—Common message header

Bits								Octets	Offset
7	6	5	4	3	2	1	0		
transportSpecific				messageType				1	0
reserved				versionPTP				1	1
messageLength								2	2
domainNumber								1	4
reserved								1	5
flagField								2	6
correctionField								8	8
reserved								4	16
sourcePortIdentity								10	20
sequenceId								2	30
controlField								1	32
logMessageInterval								1	33

Id. at p. 124.

In addition to the PTP messages in the OTU overhead, the Accused Products also receive a DMp signal in the ODU overhead associated with a first OTN node at a second OTN node. *See e.g.*:

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	15.8.2.1.6 ODU PM delay measurement (DMp) For ODU path monitoring, a one-bit path delay measurement (DMp) signal is defined to convey the start of the delay measurement test. The ODUk and ODUCn contain one instance of ODU PM DMp overhead. The DMp signal consists of a constant value (0 or 1) that is inverted at the beginning of a two-way delay measurement test. The transition from 0→1 in the sequence …0000011111…, or the transition from 1→0 in the sequence …1111100000… represents the path delay measurement start point. The new value of the DMp signal is maintained until the start of the next delay measurement test. This DMp signal is inserted by the DMp originating P-CMEP and sent to the far-end P-CMEP. This far-end P-CMEP loops back the DMp signal towards the originating P-CMEP. The originating P-CMEP measures the number of frame periods between the moment the DMp signal value is inverted and the moment this inverted DMp signal value is received back from the far-end P-CMEP. The receiver should apply a persistency check on the received DMp signal to be tolerant for bit errors emulating the start of delay measurement indication. The additional frames that are used for such persistency checking should not be added to the delay frame count. The looping P-CMEP should loop back each received DMp bit within approximately 100 µs. Refer to [ITU-T G.798] for the specific path delay measurement process specifications. NOTE 1 – Path delay measurements can be performed on-demand, to provide the momentary two-way transfer delay status, and pro-active, to provide 15-minute and 24-hour two-way transfer delay performance management snapshots. NOTE 2 – Equipment designed according to the 2008 or earlier versions of this Recommendation may not be capable of supporting this path delay monitoring. For such equipment, the DMp bit is a bit reserved for future international standardization and set to zero. NOTE 3 – This process measures a round trip delay. The one way delay may not be half of the round trip delay in the case where the transmit and receive directions of the ODU network connection are of unequal lengths (e.g., in networks deploying unidirectional protection switching). G.709 Standard at pp. 60-61.
[1.b] wherein the first time stamp is inserted in a first overhead of a first optical transport unit	At least by sending and receiving PTP messages using the OTU overhead, the Accused Products receive a first time stamp that is inserted in a first overhead of a first optical transport unit (OTU) frame. For example, a "Delay_Req" or "pDelay_Req" PTP event message containing the first time stamp may be inserted into the OSMC field of the OTU overhead of the OTU frame, as described above. *See, e.g.*:

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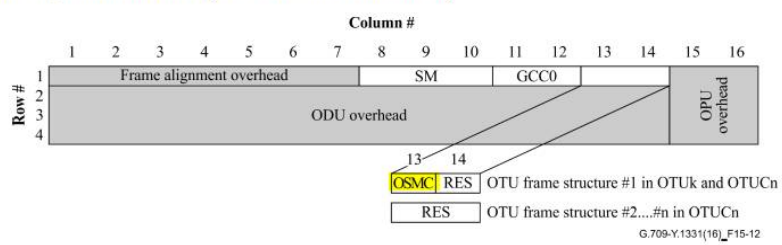
frame;	**15.7.2.4 OTU OTN synchronisation message channel (OSMC)** For synchronisation purposes, one byte is defined in the OTU overhead as an OTN synchronisation message channel to transport SSM and PTP messages within SOTU and MOTU interfaces. The OSMC bandwidth is listed in Table 15-3. The OTUk and OTUCn contain one instance of OTU OSMC overhead. NOTE 1 – OTU OSMC is not defined for MOTUm and SOTUm interfaces. NOTE 2 – Support of OTU OSMC in a SOTU or MOTU interface is optional. NOTE 3 – Equipment designed prior to Edition 5.0 of this Recommendation may not be able to support OTU OSMC via their SOTU or MOTU interfaces. NOTE 4 – SOTU and MOTU interfaces with vendor specific application identifiers may support an OSMC function. The encapsulation of the messages and overhead location are then vendor specific. G.709 Standard at pp. 54-55. **15.7.1 OTU overhead location** The OTU overhead location is shown in Figures 15-12 and 15-13. The OTUk contains one instance of OTU overhead. The OTUCn contains n instances of OTU overhead, numbered 1 to n (OTU OH #1 to OTU OH #n).  **Figure 15-12 – OTU overhead**

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	Id. at p. 50. The PTP protocol defined in the IEEE-1588 Standard discloses timestamping event messages. *See e.g.*: **6.4 PTP message classes** The protocol defines event and general PTP messages. Event messages are timed messages in that an accurate timestamp is generated at both transmission and receipt as specified in 6.6.5. General messages do not require accurate timestamps. The set of event messages consists of: a) Sync (see 13.6) b) Delay_Req (see 13.6) c) Pdelay_Req (see 13.9) d) Pdelay_Resp (see 13.10) The set of general messages consists of: — Announce (see 13.5) — Follow_Up (see 13.7) — Delay_Resp (see 13.8) — Pdelay_Resp_Follow_Up (see 13.11) — Management (see Clause 15) — Signaling (see 13.12) The Sync, Delay_Req, Follow_Up, and Delay_Resp messages are used to generate and communicate the timing information needed to synchronize ordinary and boundary clocks using the delay request-response mechanism. The Pdelay_Req, Pdelay_Resp, and Pdelay_Resp_Follow_Up messages are used to measure the link delay between two clock ports implementing the peer delay mechanism. The link delay is used to correct timing information in Sync and Follow_Up messages in systems composed of peer-to-peer transparent clocks. Ordinary and boundary clocks that implement the peer delay mechanism can synchronize using the measured link delays and the information in the Sync and Follow_Up messages. IEEE-1588 Standard at pp. 17-18.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	11. Clock offset, path delay, residence time, and asymmetry corrections **11.1 General specifications** The specifications in Clause 11 provide mechanisms for conveying timestamps generated at the sources of event messages along with any corrections needed to ensure that the recipient of the event message receives the most accurate timestamp possible. The actual distribution of the time information between the originTimestamp or preciseOriginTimestamp and the correctionField fields is implementation dependent, providing the distribution shall be such that a receiving device performing the computations on timestamp fields and correctionField, as specified in the following clauses, obtains the most accurate timestamp possible. *Id.* at pp. 108-109. **13.6 Sync and Delay_Req messages** **13.6.1 General Sync and Delay_Req message specifications** The fields of Sync and Delay_Req messages shall be as specified in Table 26. **Table 26—Sync and Delay_Req message fields** Bits: 7 6 5 4 3 2 1 0 — Octets — Offset header (see 13.3) — 34 — 0 originTimestamp — 10 — 34 **13.6.2 Sync and Delay_Req message field specifications** **13.6.2.1 originTimestamp (Timestamp)** The value of the originTimestamp field shall be as specified in 9.5.9 and 11.3.

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<table>
<tr><th>Asserted Claim (P.R. 3-1(a))</th><th>Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]</th></tr>
<tr><td></td><td>
Id. at p. 130.
13.9 Pdelay_Req message
13.9.1 General Pdelay_Req message specifications
The fields of the Pdelay_Req message shall be as specified in Table 29.
Table 29—Pdelay_Req message fields
<table>
<tr><th colspan="8">Bits</th><th rowspan="2">Octets</th><th rowspan="2">Offset</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td colspan="8">header (see 13.3)</td><td>34</td><td>0</td></tr>
<tr><td colspan="8">originTimestamp</td><td>10</td><td>34</td></tr>
<tr><td colspan="8">reserved</td><td>10</td><td>44</td></tr>
</table>
NOTE—The reserved field in the Pdelay_Req message is to make the message length match the length of the Pdelay_Resp message. In some networks and bridges, messages with unequal lengths have different transit times that introduce asymmetry errors.
13.9.2 Pdelay_Req message field specifications
13.9.2.1 originTimestamp (Timestamp)
The value of the originTimestamp shall be as specified in 11.4.3.
Id. at p. 131.
</td></tr>
</table>

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<table>
<tr><th>Asserted Claim (P.R. 3-1(a))</th><th>Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]</th></tr>
<tr><td></td><td>

13.3 Header

13.3.1 General header specifications

The common header for all PTP messages shall be as specified in Table 18.

Table 18—Common message header
<table>
<tr><th colspan="8">Bits</th><th rowspan="2">Octets</th><th rowspan="2">Offset</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td colspan="4">transportSpecific</td><td colspan="4">messageType</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">reserved</td><td colspan="4">versionPTP</td><td>1</td><td>1</td></tr>
<tr><td colspan="8">messageLength</td><td>2</td><td>2</td></tr>
<tr><td colspan="8">domainNumber</td><td>1</td><td>4</td></tr>
<tr><td colspan="8">reserved</td><td>1</td><td>5</td></tr>
<tr><td colspan="8">flagField</td><td>2</td><td>6</td></tr>
<tr><td colspan="8">correctionField</td><td>8</td><td>8</td></tr>
<tr><td colspan="8">reserved</td><td>4</td><td>16</td></tr>
<tr><td colspan="8">sourcePortIdentity</td><td>10</td><td>20</td></tr>
<tr><td colspan="8">sequenceId</td><td>2</td><td>30</td></tr>
<tr><td colspan="8">controlField</td><td>1</td><td>32</td></tr>
<tr><td colspan="8">logMessageInterval</td><td>1</td><td>33</td></tr>
</table>

Id. at p. 124.
</td></tr>
<tr><td>[1.c] extracting information of the first time stamp from the first overhead of the first optical transport unit frame,</td><td>At least by sending and receiving PTP messages (e.g., "Delay_Req" messages) using the OTU overhead, the Accused Products extract information of the first time stamp from the first overhead of the first optical transport unit frame.

As noted earlier, the OSMC field of the OTU Overhead is used to transport PTP messages, including PTP event messages.

For example, for the delay request-response mechanism, one particular PTP event message, the "Delay_Req" message, is sent</td></tr>
</table>

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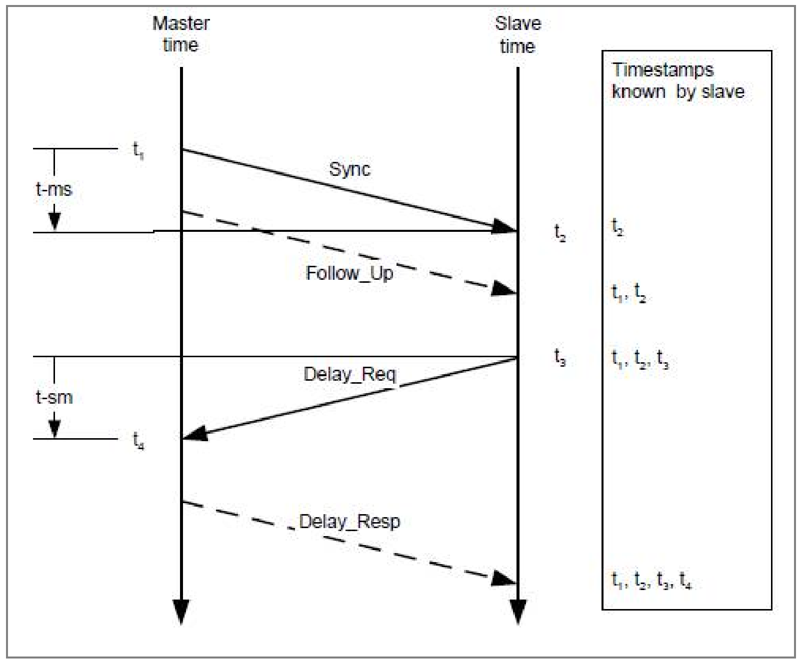
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	from a slave clock at a first node to a master clock at a second node. The "Delay_Req" message is timestamped upon egress. The "Delay_Req" message contains a timestamp in the "originTimestamp" message field as well as a "correctionField" in the header, as described above. At least the "originTimestamp" and/or "correctionField" is information extracted by the second node (*i.e.*, the node maintaining the master clock) from the overhead of the OTU frame, *i.e.*, from the OTU Overhead.  IEEE-1588 Standard at pp. 34, 110.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]

11.3.2 Delay request-response mechanism operational specifications

The actual value of the <meanPathDelay> shall be measured and computed as follows for each instance of a delay request-response measurement:

a) The master node prepares and issues a Sync message per 9.5.9. If the node is a two-step clock, it also prepares and issues a Follow_Up message per 9.5.9.4.

b) The slave node shall:

1) Upon receipt of the Sync message from the master generate timestamp t_2.

2) If asymmetry corrections are required, modify the correctionField of the received Sync message per 11.6.2.

3) If required to send a Delay_Req message based on the timing requirements of subclause 9.5.11.2:

i) Prepare a Delay_Req message with the correctionField (see 13.3.2.7) set to 0. The originTimestamp shall be set to 0 or an estimate no worse than ±1 s of the egress time of the Delay_Req message.

ii) If asymmetry corrections are required, modify the correctionField per 11.6.3.

iii) Send the Delay_Req message and generate and save timestamp t_3.

Id. at p. 111.

See also id. at pp. 130, 131, and 124:

Table 26—Sync and Delay_Req message fields

Bits								Octets	Offset
7	6	5	4	3	2	1	0		
header (see 13.3)								34	0
originTimestamp								10	34

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	Table 29—Pdelay_Req message fields Bits 7 6 5 4 3 2 1 0 | Octets | Offset header (see 13.3) | 34 | 0 originTimestamp | 10 | 34 reserved | 10 | 44 **Table 18—Common message header** Bits 7 6 5 4 3 2 1 0 | Octets | Offset transportSpecific (bits 7–4), messageType (bits 3–0) | 1 | 0 reserved (bits 7–4), versionPTP (bits 3–0) | 1 | 1 messageLength | 2 | 2 domainNumber | 1 | 4 reserved | 1 | 5 flagField | 2 | 6 correctionField | 8 | 8 reserved | 4 | 16 sourcePortIdentity | 10 | 20 sequenceId | 2 | 30 controlField | 1 | 32 logMessageInterval | 1 | 33 For example, the receiving node (*e.g.* the master clock at the second node) extracts the correctionField of the "Delay_Req" message (*e.g.*, sent by the slave clock at the first node) so that it can add the "Delay_Req" message's correctionField to its own correctionField. *Id.* The sequenceID and sourcePortIdentity fields are also extracted from the first timestamp and copied over to the "Delay_Resp" message:

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	c) Upon receipt of the Delay_Req message, the master node shall : 1) Generate timestamp t_4 2) Prepare a Delay_Resp message 3) Copy the sequenceId field from the Delay_Req message to the sequenceId field of the Delay_Resp message 4) Copy the sourcePortIdentity field from the Delay_Req message to the requestingPortIdentity field of the Delay_Resp message 5) Copy the domainNumber field from the Delay_Req message to the domainNumber field of the Delay_Resp message 6) Set the correctionField of the Delay_Resp message to 0 7) Add the correctionField of the Delay_Req message to the correctionField of the Delay_Resp message 8) Set the receiveTimestamp field of the Delay_Resp message to the seconds and nanoseconds portion of the time t_4 9) Subtract any fractional nanosecond portion of t_4 from the correctionField of the Delay_Resp message 10) Issue the Delay_Resp message *Id.* at p. 111. As another example, for the peer delay mechanism, one particular PTP event message, the "Pdelay_Req" message is sent from one clock at a first node to a second clock at a second node. The "Pdelay_Req" message is timestamped upon egress. The "PDelay_Req" message contains a timestamp in the "originTimestamp message field as well as a "correctionField" in the header. The "originTimestamp" and/or "correctionField" is information extracted by the second node from the overhead of the OTU frame, *i.e.*, from the OTU Overhead. *See* 1.c above.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	13.9 Pdelay_Req message **13.9.1 General Pdelay_Req message specifications** The fields of the Pdelay_Req message shall be as specified in Table 29. **Table 29—Pdelay_Req message fields** Bits: 7 6 5 4 3 2 1 0 — Octets — Offset header (see 13.3) — 34 — 0 originTimestamp — 10 — 34 reserved — 10 — 44 NOTE—The reserved field in the Pdelay_Req message is to make the message length match the length of the Pdelay_Resp message. In some networks and bridges, messages with unequal lengths have different transit times that introduce asymmetry errors. **13.9.2 Pdelay_Req message field specifications** **13.9.2.1 originTimestamp (Timestamp)** The value of the originTimestamp shall be as specified in 11.4.3. **13.10 Pdelay_Resp message** **13.10.1 General Pdelay_Resp message specifications** The fields of the Pdelay_Resp message shall be as specified in Table 30. **Table 30—Pdelay_Resp message fields** Bits: 7 6 5 4 3 2 1 0 — Octets — Offset header (see 13.3) — 34 — 0 requestReceiptTimestamp — 10 — 34 requestingPortIdentity — 10 — 44 **13.10.2 Pdelay_Resp message field specifications** **13.10.2.1 requestReceiptTimestamp (Timestamp)** The value of the requestReceiptTimestamp shall be as specified in 11.4.3. *Id.* at p. 131. In addition to literally infringing this claim element, the Accused Products also infringe under the doctrine of equivalents. The Accused Products perform functionality at least equivalent to and insubstantially different from the claimed method where information of the first time stamp is extracted from the first overhead of the first optical transport unit frame to perform

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	substantially the same function (*e.g.*, extracting information relating to a timestamp from the overhead of an optical transport unit frame) in substantially the same way (*e.g.*, using a value of a field in a received timestamp message to copy or add to a corresponding field in another timestamp message), to achieve substantially the same result (*e.g.*, obtaining information from the first timestamp).
[1.d] wherein the information reflects a round trip delay of a network;	At least by sending and receiving PTP messages using the OTU overhead, the Accused Products extract information of the first time stamp that reflects a round trip delay of a network. In the Accused Products, the PTP protocol as defined in the IEEE-1588 Standard is used for frequency, phase, and time synchronization, which measures roundtrip delay: **9.1 Introduction to PTP Clock** A Precision Time Protocol (PTP) clock is compliant with the IEEE 1588 V2 protocol and can realize synchronization of frequency and time. Hence, the scheduled synchronization index of the entire network is greatly improved. In a distributed system, clocks and time are usually applied to the following scenarios: • Frequency-based application Frequency-based application is mainly used in the scenario where multiple control points of the distributed system need to be synchronized. Each control point needs to perform sampling, control algorithm, and control commands simultaneously. • Time stamp-based application Time stamp is mainly used in the scenario where the absolute time value needs to be measured. After time stamps are appended to specific events, the sequence of the events can be determined if the time stamps have the same reference. The key technology to realize the preceding applications is time synchronization. The purpose of time synchronization is to accurately and precisely transfer reference time to each control point. The IEEE 1588 standard has made great progress in time precision. IEEE 1588 is usually referred to as PTP, that is, precision time protocol. A PTP clock can realize synchronization of frequency and time, and the precision of the PTP clock is accurate to within nanoseconds. Synchronization of frequency and time based on the IEEE 1588 protocol is one of the technical revolutions and innovations that carrier-class IP networks make for transformation. The equipment that has the PTP clock function can realize synchronization of frequency and time network-wide on the synchronous optical transmission network. Telecommunications network needs to carry services of different types. Certain services require time synchronization and high precision. For example, the CDMA system and orientation location service. The PTP clock is mainly used in the preceding scenarios and provides precise time synchronization to meet service requirements. Huawei Feature Description at § 9.1.

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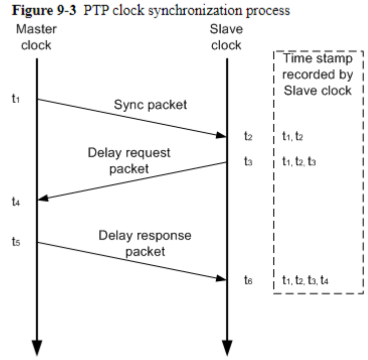
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	11. Clock offset, path delay, residence time, and asymmetry corrections **11.1 General specifications** The specifications in Clause 11 provide mechanisms for conveying timestamps generated at the sources of event messages along with any corrections needed to ensure that the recipient of the event message receives the most accurate timestamp possible. The actual distribution of the time information between the originTimestamp or preciseOriginTimestamp and the correctionField fields is implementation dependent, providing the distribution shall be such that a receiving device performing the computations on timestamp fields and correctionField, as specified in the following clauses, obtains the most accurate timestamp possible. IEEE-1588 Standard at pp. 108-109. As noted above, the "Delay_Req" packet is a PTP event message that is used to measure a round trip "delay time caused by network transmission." **PTP Clock Synchronization Mechanism** The PTP protocol is based on the most accurate match time at which synchronous data packets are propagated and received. Each slave clock is synchronized with the master clock by exchanging the synchronous packets with the master clock. The PTP clock synchronization process is shown in Figure 9-3. **Figure 9-3** PTP clock synchronization process  Huawei Feature Description at § 9.4.3.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	The method of calculating the time difference between the master and slave clocks and the link delay is as follows: Because $t_1 - t_2 = \text{Delay} - \text{Offset}$ $t_4 - t_3 = \text{Delay} + \text{Offset}$ Hence, $\text{Offset} = [(t_4 - t_3) - (t_2 - t_1)]/2$ $\text{Delay} = [(t_4 - t_3) + (t_2 - t_1)]/2$ NOTE • Offset: The time difference between the master and slave clocks. • Delay: The delay time caused by network transmission. *Id.* For example, as stated earlier, the "originTimestamp" represents the egress timestamp of a PTP event message such as the "Delay_Req" message. As another example, the "correctionField" of the "Delay_Req" message represents the value of the correction that accounts for the residence time in a transparent clock. *See* IEEE-1588 at 127.

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<table>
<tr><th>Asserted Claim (P.R. 3-1(a))</th><th>Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]</th></tr>
<tr><td></td><td>
Table 21—correctionField semantics
<table>
<tr><th>Message type</th><th>correctionField description</th></tr>
<tr><td>Sync</td><td>Corrections for fractional nanoseconds, residence time in transparent clocks (see 11.5.2), path delay in peer-to-peer clocks (see 11.4.5.1), and asymmetry corrections (see 11.6.2)</td></tr>
<tr><td>Delay_Req</td><td>Corrections for fractional nanoseconds, residence time in transparent clocks (see 11.5.3), and asymmetry corrections (see 11.6.3)</td></tr>
<tr><td>Pdelay_Req</td><td>Corrections for fractional nanoseconds, residence time in transparent clocks (see 11.5.4), and asymmetry corrections (see 11.6.4)</td></tr>
<tr><td>Pdelay_Resp</td><td>Corrections for fractional nanoseconds, residence time in transparent clocks (see 11.5.4), and asymmetry corrections (see 11.6.5)</td></tr>
<tr><td>Follow_Up</td><td>Corrections for fractional nanoseconds, residence time in transparent clocks (see 11.5.2), path delay in peer-to-peer clocks (see 11.4.5.1), and asymmetry corrections (see 11.6.2)</td></tr>
<tr><td>Delay_Resp</td><td>Corrections for fractional nanoseconds, residence time in transparent clocks (see 11.5.3), and asymmetry corrections (see 11.6.3)</td></tr>
<tr><td>Pdelay_Resp_Follow_Up</td><td>Corrections for fractional nanoseconds, residence time in transparent clocks (see 11.5.4), and asymmetry corrections (see 11.6.4 and 11.6.5)</td></tr>
<tr><td>Announce</td><td>Zero</td></tr>
<tr><td>Signaling</td><td>Zero</td></tr>
<tr><td>Management</td><td>Zero</td></tr>
</table>
Because the residence time of the "correctionField" and /or the "originTimestamp" are used to calculate a round-trip path delay, the "correctionField" and/or "originTimestamp" reflect a round trip delay of the network. For example, the "originTimestamp" within the Delay_Req message represents the propagation time of the "Sync" message from master to slave (t-ms in the diagram below) when adjusting for the residence time (stored in the "correctionField") through the slave's transparent clock. This value reflects a round trip delay of a network by doubling the one-way delay t-ms since "[m]essages from master to slave and slave to master shall traverse the same network path." Id. at pp. 46-47. In addition, the delay request-response mechanism shown below, which includes both the "correctionField" and "originTimestamp" of the Deay_Req messages, is used to measure the <meanPathDelay> between a pair of PTP ports. The value [t-ms + t-sm] shown below reflects the round trip delay of the network (which is twice the <meanPathDelay>.
</td></tr>
</table>

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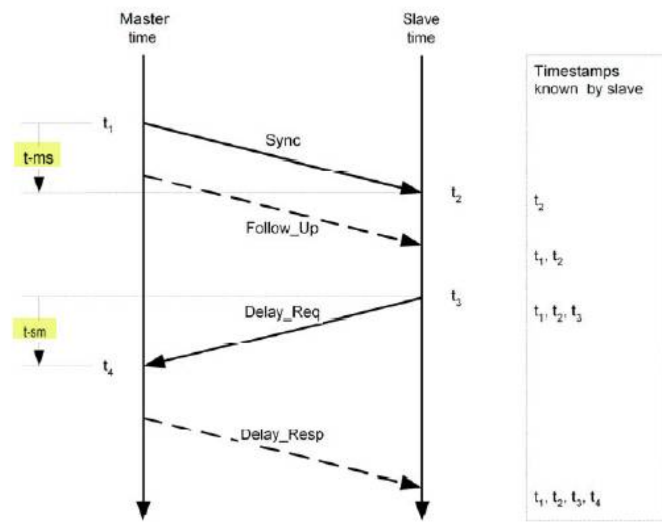
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	11.3 Delay request-response mechanism **11.3.1 Delay request-response mechanism general requirements** The delay request-response mechanism measures the <meanPathDelay> between a pair of PTP ports, each of which supports the state machine of 9.2.5. The delay request-response mechanism uses the messages Sync, Delay_Req, Delay_Resp and possibly Follow_Up as shown in the timing diagram of Figure 34. This mechanism shall be executed independently in each supported domain of the two clocks. The timestamps t_1 and t_2 for the Sync message and t_3 and t_4 for the Delay_Req message of Figure 34 shall be measured as defined in 7.3.4.2. Timestamps t_1 and t_4 shall be measured using the time of the master node, and the timestamps t_2 and t_3 shall be measured using the time of the slave node. If the delayAsymmetry (see 7.4.2) of the paths connected to the ingress and egress ports is known, the corrections of 11.6 shall be implemented. NOTE—The nominal value of the <meanPathDelay> is computed as <meanPathDelay> = $[(t_2 - t_1) + (t_4 - t_3)]/2 = [(t_2 - t_3) + (t_4 - t_1)]/2$.  **Figure 34—Delay request-response path length measurement** IEEE-1588 Standard at p. 110.

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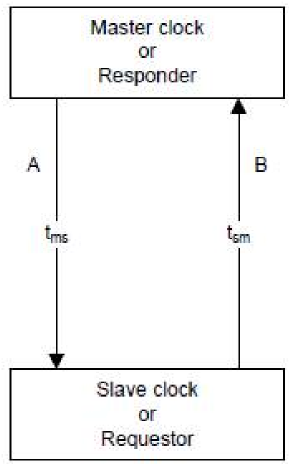
	Any asymmetry in the propagation times between t-ms and t-sm is accounted for by the "delayAsymmetry" value: The basis for these attributes is illustrated in Figure 20.  **Figure 20—Propagation asymmetry** The <meanPathDelay> is the mean value of t_{ms} and t_{sm}; i.e., <meanPathDelay> = $(t_{ms} + t_{sm})/2$. The value of delayAsymmetry is required for the computations of the actual delay in the master-to-slave or responder-to-requestor direction, t_{ms}, used in Clause 11. In many cases, the value of delayAsymmetry is below the error budget of the synchronization application. The attribute delayAsymmetry is defined as follows: $t_{ms} = \langle meanPathDelay \rangle + delayAsymmetry$ $t_{sm} = \langle meanPathDelay \rangle - delayAsymmetry$ *Id.* at p. 47.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	c) Upon receipt of the Delay_Req message, the master node shall : 1) Generate timestamp t_4 2) Prepare a Delay_Resp message 3) Copy the sequenceId field from the Delay_Req message to the sequenceId field of the Delay_Resp message 4) Copy the sourcePortIdentity field from the Delay_Req message to the requestingPortIdentity field of the Delay_Resp message 5) Copy the domainNumber field from the Delay_Req message to the domainNumber field of the Delay_Resp message 6) Set the correctionField of the Delay_Resp message to 0 7) Add the correctionField of the Delay_Req message to the correctionField of the Delay_Resp message d) Upon receipt of the Delay_Resp message by the slave: 1) If the received Sync message indicated that a Follow_Up message will not be received, the <meanPathDelay> shall be computed as: <meanPathDelay> = [(t_2 - t_3) + (receiveTimestamp of Delay_Resp message – originTimestamp of Sync message) – correctionField of Sync message – correctionField of Delay_Resp message]/2. 2) If the received Sync message indicated that a Follow_Up message will be received, the <meanPathDelay> shall be computed as: <meanPathDelay> = [(t_2 - t_3) + (receiveTimestamp of Delay_Resp message – preciseOriginTimestamp of Follow_Up message) – correctionField of Sync message– correctionField of Follow_Up message – correctionField of Delay_Resp message]/2. IEEE-1588 Standard at pp. 111-112. Likewise, the PTP peer delay mechanism measures port-to-port propagation time, i.e. link delay – which informs the round-trip time. *See e.g.*:

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	11.4 Peer delay mechanism **11.4.1 Peer delay mechanism general requirements** The peer delay mechanism measures the port-to-port propagation time, i.e., the link delay, between two communicating ports supporting the peer delay mechanism. This measurement should be made on all ports of a device including those that are blocked by lower level protocols. The addressing or other mechanisms to support this requirement are network specific and are specified in the relevant annexes to this standard. The link delay measurement shall be made independently by each port implementing the peer delay mechanism. *Id.* at p. 112.

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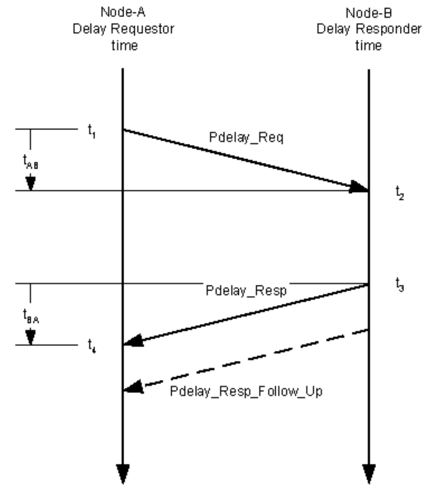
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	 **Figure 35—Peer delay link measurement** The timestamps t_1 and t_2 for the Pdelay_Req message and t_3 and t_4 for the Pdelay_Resp message of Figure 35 are measured as defined in 7.3.4. If the delayAsymmetry (see 7.4.2) of the links connected to the ingress and egress ports are known, the corrections of 11.6 shall be implemented. The timestamps t_1 and t_4 shall be measured by Node-A as follows: — If Node-A is a peer-to-peer transparent clock, the timescale used is specified in 10.1. — If Node-A is an ordinary or boundary clock, the timescale used is that of the domain of the clock. Timestamps t_2 and t_3 shall be measured by Node-B as follows: — If Node-B is a peer-to-peer transparent clock, the timescale used is specified in 10.1. — If Node-B is an ordinary or boundary clock, the timescale used is that of the domain of the clock. NOTE—The nominal value of the <meanPathDelay> is computed as <meanPathDelay> = $[(t_2 - t_1) + (t_4 - t_3)]/2 = [(t_2 - t_3) + (t_4 - t_1)]/2$. The actual value is specified in 11.4.3. **11.4.2 Peer delay message timing** The transmission of a Pdelay_Req message from a requesting port shall be limited as follows: — The initial Pdelay_Req message may be transmitted when required. — Subsequent Pdelay_Req messages shall be transmitted such that the logarithm to the base 2 of the mean value of the interval in seconds between message transmissions is not less than the value of the portDS.logMinPdelayReqInterval member of the data set of the requestor clock. *Id.* at p. 113.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	Pdelay_Resp messages should be transmitted as soon as possible after the receipt of the associated Pdelay_Req message. Pdelay_Resp_Follow_Up messages should be transmitted as soon as possible after the transmission of the associated Pdelay_Resp message. **11.4.3 Peer delay mechanism operational specifications** The actual value of the meanPathDelay shall be measured and computed as follows for each instance of a peer delay request-response measurement: a) The delay requestor, Node-A: 1) Prepares a Pdelay_Req message. The correctionField (see 13.3.2.7) shall be set to 0. i) If Node-A is an ordinary or boundary clock, then the domainNumber field of the header shall be set to the domain of Node-A. ii) If Node-A is a syntonized peer-to-peer transparent clock, the domainNumber field of the header should be set to the domain being measured, either the primary syntonization domain, or one of the alternate domains if syntonization to multiple domains is implemented on Node-A. iii) If Node-A is not a syntonized peer-to-peer transparent clock, the domainNumber field of the header shall be set to 0. 2) If asymmetry corrections are required, shall modify the correctionField per 11.6.4. 3) Shall set the originTimestamp to 0 or an estimate no worse than ±1 s of the egress timestamp, t_1, of the Pdelay_Req message. 4) Shall send the Pdelay_Req message and generate and save timestamp t_1. b) If the delay responder, Node-B, is a one-step clock, it shall: 1) Generate timestamp t_2 upon receipt of the Pdelay_Req message 2) Prepare a Pdelay_Resp message 3) Copy the sequenceId field from the Pdelay_Req message to the sequenceId field of the Pdelay_Resp message 4) Copy the sourcePortIdentity field from the Pdelay_Req message to the requestingPortIdentity field of the Pdelay_Resp message 5) Copy the domainNumber field from the Pdelay_Req message to the domainNumber field of the Pdelay_Resp message 6) Copy the correctionField from the Pdelay_Req message to the correctionField of the Pdelay_Resp message 7) Then: i) Set to 0 the requestReceiptTimestamp field of the Pdelay_Resp message ii) Issue the Pdelay_Resp message and generate timestamp t_3 upon sending *Id.* at p. 114.

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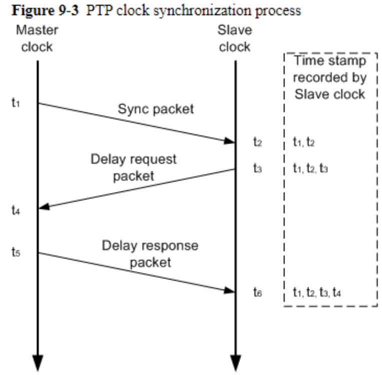
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	In addition to literally infringing this claim element, the Accused Products also infringe under the doctrine of equivalents. The Accused Products are at least equivalent to and insubstantially different from the claimed method where information extracted from the first time stamp from the first overhead of the first optical transport unit frame reflects round-trip delay of a network and each performs at least substantially the same function (*e.g.*, extracting information from a received message) in substantially the same way (*e.g.*, relying on the extracted information to more accurately calculate the round trip delay) to achieve substantially the same result (*e.g.*, calculating the round-trip delay of a network).
[1.e] generating a second time stamp based at least in part on the extracted information of the first time stamp associated with the first location,	At least by sending and receiving PTP messages using the OTU overhead, the Accused Products generate a second time stamp based at least in part on the extracted information of the first time stamp associated with the first location. For example, the Master clock at the second node generates a timestamp when the "Delay_Resp" delay response packet is sent from the master clock at the second OTN node to the Slave clock at the first OTN node. **PTP Clock Synchronization Mechanism** The PTP protocol is based on the most accurate match time at which synchronous data packets are propagated and received. Each slave clock is synchronized with the master clock by exchanging the synchronous packets with the master clock. The PTP clock synchronization process is shown in Figure 9-3. **Figure 9-3** PTP clock synchronization process  Huawei Feature Description at § 9.4.3. The timestamp of "Delay_Resp" is generated based at least in part on the previously extracted "correctionField" and/or

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	"originTimestamp" of the "Delay_Req" packet, because the Master clock at the second node adds the extracted correctionField of the "Delay_Req" packet to the correctionField of the "Delay_Resp" packet. *See* IEEE-1588 Standard at p. 111. c) Upon receipt of the Delay_Req message, the master node shall : 1) Generate timestamp t_4 2) Prepare a Delay_Resp message 3) Copy the sequenceId field from the Delay_Req message to the sequenceId field of the Delay_Resp message 4) Copy the sourcePortIdentity field from the Delay_Req message to the requestingPortIdentity field of the Delay_Resp message 5) Copy the domainNumber field from the Delay_Req message to the domainNumber field of the Delay_Resp message 6) Set the correctionField of the Delay_Resp message to 0 7) Add the correctionField of the Delay_Req message to the correctionField of the Delay_Resp message In addition, in order to build the master-slave hierarchy, a best master clock (BMC) algorithm is used to determine the grandmaster clock (GMC). "[T]he BMC algorithm transfers the master clock and reference time to each node level by level, to realize the optimum clock precision." Huawei Feature Description at §§ 9.4.1, 9.4.2. As another example, the timestamp of PDelay_Resp is generated based at least in part on the previously extracted correctionField of the "PDelay_Req" packet, because the clock at the second node adds the extracted correctionField of the PDelay_Req packet to the correctionField of the "PDelay_Resp" packet.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	11.4.3 Peer delay mechanism operational specifications The actual value of the meanPathDelay shall be measured and computed as follows for each instance of a peer delay request-response measurement: a) The delay requestor, Node-A: 1) Prepares a Pdelay_Req message. The correctionField (see 13.3.2.7) shall be set to 0. i) If Node-A is an ordinary or boundary clock, then the domainNumber field of the header shall be set to the domain of Node-A. ii) If Node-A is a syntonized peer-to-peer transparent clock, the domainNumber field of the header should be set to the domain being measured, either the primary syntonization domain, or one of the alternate domains if syntonization to multiple domains is implemented on Node-A. iii) If Node-A is not a syntonized peer-to-peer transparent clock, the domainNumber field of the header shall be set to 0. 2) If asymmetry corrections are required, shall modify the correctionField per 11.6.4. 3) Shall set the originTimestamp to 0 or an estimate no worse than ±1 s of the egress timestamp, t_1, of the Pdelay_Req message. 4) Shall send the Pdelay_Req message and generate and save timestamp t_1. b) If the delay responder, Node-B, is a one-step clock, it shall: 1) Generate timestamp t_2 upon receipt of the Pdelay_Req message 2) Prepare a Pdelay_Resp message 3) Copy the sequenceId field from the Pdelay_Req message to the sequenceId field of the Pdelay_Resp message 4) Copy the sourcePortIdentity field from the Pdelay_Req message to the requestingPortIdentity field of the Pdelay_Resp message 5) Copy the domainNumber field from the Pdelay_Req message to the domainNumber field of the Pdelay_Resp message 6) Copy the correctionField from the Pdelay_Req message to the correctionField of the Pdelay_Resp message 7) Then: i) Set to 0 the requestReceiptTimestamp field of the Pdelay_Resp message ii) Issue the Pdelay_Resp message and generate timestamp t_3 upon sending IEEE-1588 Standard at p. 114.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	In addition to PTP messages, the Accused Products also generate other types of time stamps, such as the DMp in the ODU overhead. *See e.g.*: **15.8.2.1.6 ODU PM delay measurement (DMp)** For ODU path monitoring, a one-bit path delay measurement (DMp) signal is defined to convey the start of the delay measurement test. The ODUk and ODUCn contain one instance of ODU PM DMp overhead. The DMp signal consists of a constant value (0 or 1) that is inverted at the beginning of a two-way delay measurement test. The transition from 0→1 in the sequence …0000011111…, or the transition from 1→0 in the sequence …1111100000… represents the path delay measurement start point. The new value of the DMp signal is maintained until the start of the next delay measurement test. This DMp signal is inserted by the DMp originating P-CMEP and sent to the far-end P-CMEP. This far-end P-CMEP loops back the DMp signal towards the originating P-CMEP. The originating P-CMEP measures the number of frame periods between the moment the DMp signal value is inverted and the moment this inverted DMp signal value is received back from the far-end P-CMEP. The receiver should apply a persistency check on the received DMp signal to be tolerant for bit errors emulating the start of delay measurement indication. The additional frames that are used for such persistency checking should not be added to the delay frame count. The looping P-CMEP should loop back each received DMp bit within approximately 100 µs. Refer to [ITU-T G.798] for the specific path delay measurement process specifications. NOTE 1 – Path delay measurements can be performed on-demand, to provide the momentary two-way transfer delay status, and pro-active, to provide 15-minute and 24-hour two-way transfer delay performance management snapshots. NOTE 2 – Equipment designed according to the 2008 or earlier versions of this Recommendation may not be capable of supporting this path delay monitoring. For such equipment, the DMp bit is a bit reserved for future international standardization and set to zero. NOTE 3 – This process measures a round trip delay. The one way delay may not be half of the round trip delay in the case where the transmit and receive directions of the ODU network connection are of unequal lengths (e.g., in networks deploying unidirectional protection switching). G.709 Standard at pp. 60-61.
[1.f] wherein the	In the Accused Products, the second time stamp includes at least part of the extracted information of the first time stamp.

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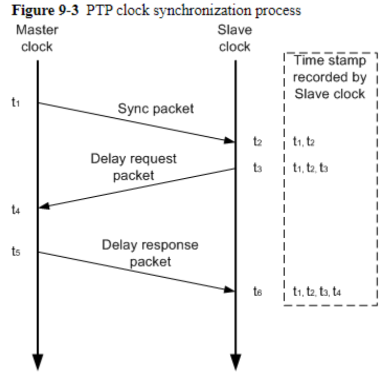
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
second time stamp includes at least part of the extracted information of the first time stamp; and	For example, the "Delay_Resp" packet includes at least part of the correctionField of the "Delay_Req" packet, because it adds the correctionField of the "Delay_Req" packet to its own correctionField. **PTP Clock Synchronization Mechanism** The PTP protocol is based on the most accurate match time at which synchronous data packets are propagated and received. Each slave clock is synchronized with the master clock by exchanging the synchronous packets with the master clock. The PTP clock synchronization process is shown in Figure 9-3. **Figure 9-3** PTP clock synchronization process  Huawei Feature Description at § 9.4.3. In addition, as described above, the sequenceID and sourcePortIdentity fields are also extracted from the first timestamp and copied over to the "Delay_Resp" message:

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	c) Upon receipt of the Delay_Req message, the master node shall : 1) Generate timestamp t_4 2) Prepare a Delay_Resp message 3) Copy the sequenceId field from the Delay_Req message to the sequenceId field of the Delay_Resp message 4) Copy the sourcePortIdentity field from the Delay_Req message to the requestingPortIdentity field of the Delay_Resp message 5) Copy the domainNumber field from the Delay_Req message to the domainNumber field of the Delay_Resp message 6) Set the correctionField of the Delay_Resp message to 0 7) Add the correctionField of the Delay_Req message to the correctionField of the Delay_Resp message 8) Set the receiveTimestamp field of the Delay_Resp message to the seconds and nanoseconds portion of the time t_4 9) Subtract any fractional nanosecond portion of t_4 from the correctionField of the Delay_Resp message 10) Issue the Delay_Resp message *Id.* at p. 111. Similarly, for peer delay mechanisms, *see e.g.*:

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	b) If the delay responder, Node-B, is a one-step clock, it shall: 1) Generate timestamp t_2 upon receipt of the Pdelay_Req message 2) Prepare a Pdelay_Resp message 3) Copy the sequenceId field from the Pdelay_Req message to the sequenceId field of the Pdelay_Resp message 4) Copy the sourcePortIdentity field from the Pdelay_Req message to the requestingPortIdentity field of the Pdelay_Resp message 5) Copy the domainNumber field from the Pdelay_Req message to the domainNumber field of the Pdelay_Resp message 6) Copy the correctionField from the Pdelay_Req message to the correctionField of the Pdelay_Resp message 7) Then: i) Set to 0 the requestReceiptTimestamp field of the Pdelay_Resp message ii) Issue the Pdelay_Resp message and generate timestamp t_3 upon sending *Id.* at p. 114. In addition, in order to build the master-slave hierarchy, a best master clock (BMC) algorithm is used to determine the grandmaster clock (GMC). "[T]he BMC algorithm transfers the master clock and reference time to each node level by level, to realize the optimum clock precision." Huawei Feature Description at §§ 9.4.1, 9.4.2.
[1.g] transmitting the second time	The Accused Products transmit the second time stamp in a second overhead of a second transport unit frame to the first location wherein the second time stamp is used to measure the round trip delay of the network.

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<table>
<tr><th>Asserted Claim (P.R. 3-1(a))</th><th>Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]</th></tr>
<tr><td>stamp in a second overhead of a second transport unit frame to the first location wherein the second time stamp is used to measure the round trip delay of the network.</td><td>

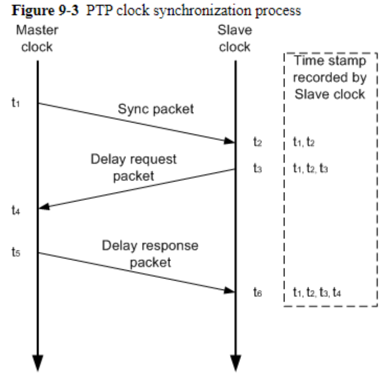
For example, the PTP synchronization process includes transmitting the second timestamp (the information within the "Delay_Resp" messages shown below) from the master clock at the second node back to the slave clock at the first node using a delay request-response mechanism. *See e.g.*:

PTP Clock Synchronization Mechanism

The PTP protocol is based on the most accurate match time at which synchronous data packets are propagated and received. Each slave clock is synchronized with the master clock by exchanging the synchronous packets with the master clock.

The PTP clock synchronization process is shown in Figure 9-3.

Figure 9-3 PTP clock synchronization process



Huawei Feature Description at § 9.4.3.

As discussed above, the Delay_Resp message is a PTP message that is carried in the OSMC field of the OTU Overhead. The Delay_Resp message sent by the master clock at the second node to the slave clock at the first node. *See e.g.*:

</td></tr>
</table>

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	The method of calculating the time difference between the master and slave clocks and the link delay is as follows: Because $t_1 - t_2 = \text{Delay} - \text{Offset}$ $t_4 - t_3 = \text{Delay} + \text{Offset}$ Hence, $\text{Offset} = [(t_4 - t_3) - (t_2 - t_1)]/2$ $\text{Delay} = [(t_4 - t_3) + (t_2 - t_1)]/2$ **NOTE** • Offset: The time difference between the master and slave clocks. • Delay: The delay time caused by network transmission. Huawei Feature Description at § 9.4.3. **11.3.1 Delay request-response mechanism general requirements** The delay request-response mechanism measures the <meanPathDelay> between a pair of PTP ports, each of which supports the state machine of 9.2.5. The delay request-response mechanism uses the messages Sync, Delay_Req, Delay_Resp and possibly Follow_Up as shown in the timing diagram of Figure 34. This mechanism shall be executed independently in each supported domain of the two clocks. The timestamps t_1 and t_2 for the Sync message and t_3 and t_4 for the Delay_Req message of Figure 34 shall be measured as defined in 7.3.4.2. Timestamps t_1 and t_4 shall be measured using the time of the master node, and the timestamps t_2 and t_3 shall be measured using the time of the slave node. If the delayAsymmetry (see 7.4.2) of the paths connected to the ingress and egress ports is known, the corrections of 11.6 shall be implemented. NOTE—The nominal value of the <meanPathDelay> is computed as <meanPathDelay> = $[(t_2 - t_1) + (t_4 - t_3)]/2 = [(t_2 - t_3) + (t_4 - t_1)]/2$.

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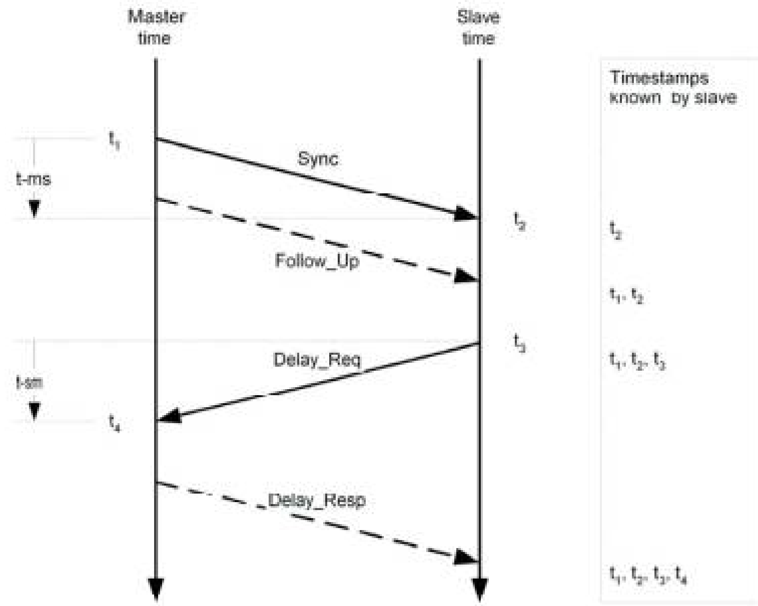
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	 **Figure 34—Delay request-response path length measurement** IEEE-1588 Standard at p. 110.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	c) Upon receipt of the Delay_Req message, the master node shall : 1) Generate timestamp t_4 2) Prepare a Delay_Resp message 3) Copy the sequenceId field from the Delay_Req message to the sequenceId field of the Delay_Resp message 4) Copy the sourcePortIdentity field from the Delay_Req message to the requestingPortIdentity field of the Delay_Resp message 5) Copy the domainNumber field from the Delay_Req message to the domainNumber field of the Delay_Resp message 6) Set the correctionField of the Delay_Resp message to 0 7) Add the correctionField of the Delay_Req message to the correctionField of the Delay_Resp message 8) Set the receiveTimestamp field of the Delay_Resp message to the seconds and nanoseconds portion of the time t_4 9) Subtract any fractional nanosecond portion of t_4 from the correctionField of the Delay_Resp message 10) Issue the Delay_Resp message *Id.* at p. 111.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	d) Upon receipt of the Delay_Resp message by the slave: 1) If the received Sync message indicated that a Follow_Up message will not be received, the <meanPathDelay> shall be computed as: <meanPathDelay> = [(t_2 - t_3) + (receiveTimestamp of Delay_Resp message – originTimestamp of Sync message) – correctionField of Sync message – correctionField of Delay_Resp message]/2. 2) If the received Sync message indicated that a Follow_Up message will be received, the <meanPathDelay> shall be computed as: <meanPathDelay> = [(t_2 - t_3) + (receiveTimestamp of Delay_Resp message – preciseOriginTimestamp of Follow_Up message) – correctionField of Sync message– correctionField of Follow_Up message – correctionField of Delay_Resp message]/2. *Id.* at p. 112. As discussed above, in the example of the peer delay mechanism, the PDelay_Resp message is a PTP message that is carried in the OSMC field of the OTU Overhead. The PDelay_Resp message is sent by the clock at the second node to the clock at the first node. *See e.g.*:

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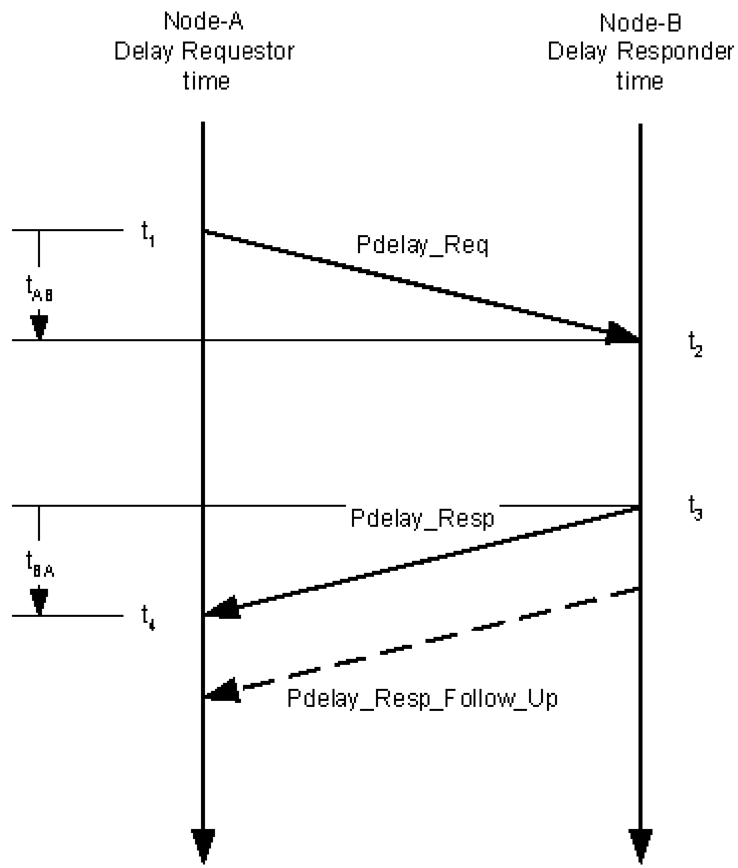
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	 **Figure 35—Peer delay link measurement**

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	b) If the delay responder, Node-B, is a one-step clock, it shall: 1) Generate timestamp t_2 upon receipt of the Pdelay_Req message 2) Prepare a Pdelay_Resp message 3) Copy the sequenceId field from the Pdelay_Req message to the sequenceId field of the Pdelay_Resp message 4) Copy the sourcePortIdentity field from the Pdelay_Req message to the requestingPortIdentity field of the Pdelay_Resp message 5) Copy the domainNumber field from the Pdelay_Req message to the domainNumber field of the Pdelay_Resp message 6) Copy the correctionField from the Pdelay_Req message to the correctionField of the Pdelay_Resp message 7) Then: i) Set to 0 the requestReceiptTimestamp field of the Pdelay_Resp message ii) Issue the Pdelay_Resp message and generate timestamp t_3 upon sending *Id.* at pp. 113-114. In addition to PTP messages in the OTU overhead, the Accused Products transmit other types of time stamps, including the DMp in the ODU overhead. *See e.g.*:

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	15.8.2.1.6 ODU PM delay measurement (DMp) For ODU path monitoring, a one-bit path delay measurement (DMp) signal is defined to convey the start of the delay measurement test. The ODUk and ODUCn contain one instance of ODU PM DMp overhead. The DMp signal consists of a constant value (0 or 1) that is inverted at the beginning of a two-way delay measurement test. The transition from 0→1 in the sequence …0000011111…, or the transition from 1→0 in the sequence …1111100000… represents the path delay measurement start point. The new value of the DMp signal is maintained until the start of the next delay measurement test. This DMp signal is inserted by the DMp originating P-CMEP and sent to the far-end P-CMEP. This far-end P-CMEP loops back the DMp signal towards the originating P-CMEP. The originating P-CMEP measures the number of frame periods between the moment the DMp signal value is inverted and the moment this inverted DMp signal value is received back from the far-end P-CMEP. The receiver should apply a persistency check on the received DMp signal to be tolerant for bit errors emulating the start of delay measurement indication. The additional frames that are used for such persistency checking should not be added to the delay frame count. The looping P-CMEP should loop back each received DMp bit within approximately 100 µs. Refer to [ITU-T G.798] for the specific path delay measurement process specifications. NOTE 1 – Path delay measurements can be performed on-demand, to provide the momentary two-way transfer delay status, and pro-active, to provide 15-minute and 24-hour two-way transfer delay performance management snapshots. NOTE 2 – Equipment designed according to the 2008 or earlier versions of this Recommendation may not be capable of supporting this path delay monitoring. For such equipment, the DMp bit is a bit reserved for future international standardization and set to zero. NOTE 3 – This process measures a round trip delay. The one way delay may not be half of the round trip delay in the case where the transmit and receive directions of the ODU network connection are of unequal lengths (e.g., in networks deploying unidirectional protection switching). G.709 at 60-61. *See* claim [1.d]. In addition to literally infringing this claim element, the Accused Products also infringe under the doctrine of equivalents. The Accused Products are at least equivalent to and insubstantially different from the claimed method wherein the second time stamp is used to measure the round trip delay of the network and each performs at least substantially the same function (*e.g.*, computing

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	network delay) in substantially the same way (*e.g.*, using timestamps) to achieve substantially the same result (*e.g.*, calculating the round-trip delay of a network).
Claim 4	
4. The method according to claim 1, wherein the transmission of the second time stamp comprises associating the second time stamp with a digital wrapping circuit.	In the Accused Products, the transmission of the second time stamp comprises associating the second time stamp with a digital wrapping circuit. For example, G.709 specifies a digital wrapping circuit for encapsulating an existing frame of data, regardless of the native protocol, to create an optical data unit (ODU) within an optical transport unit (OTU). The OTN interfaces without optical layer overhead are defined with 3R processing at each end of the interface. The interfaces consist of digital and management information defined in this Recommendation as carried by a physical interface, the specifications of which are outside the scope of this Recommendation. Each interface may be associated with one or more application identifiers. Each application identifier represents either a standardized application code or a vendor specific identifier. An interface with an application code may be used to interconnect (OTN) equipment from different vendors. An interface with a vendor specific identifier is to be used to interconnect (OTN) equipment from the same vendor. **6.1 Basic signal structure** The basic structure is shown in Figures 6-1 and 6-2 and consists of a digital and an optical structure. **6.1.1 OTN digital structure** The OTN digital structure (see Figure 6-1) consists of two classes of optical transport units (OTU); the OTUk and OTUCn. The OTUk signal consists of a 4080 column by 4 row frame, which includes 256 columns allocated to contain a forward error correction code (FEC) and is operated at various bit rates that are represented by the value of k. The OTUCn signal consists of n interleaved 3824 column by 4 row frames, which do not include a FEC area and is operated at n times a basic rate that is represented by OTUC. FEC for the OTUCn signal is interface specific and not included in the OTUCn definition. G.709 at 9-10.

Exhibit 111
to Verizon's Preliminary Disclosure of Asserted Claims and Infringement Contentions (P.R. 3-1)
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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	The OTN node maintaining the master clock described above associates the second timestamp with a digial wrapping circuit by at least by copying the sequenceID and sourcePortIdentity fields from the "Delay_Req" message into the "Delay_Resp" message. c) Upon receipt of the Delay_Req message, the master node shall : 1) Generate timestamp t_4 2) Prepare a Delay_Resp message 3) Copy the sequenceId field from the Delay_Req message to the sequenceId field of the Delay_Resp message 4) Copy the sourcePortIdentity field from the Delay_Req message to the requestingPortIdentity field of the Delay_Resp message 5) Copy the domainNumber field from the Delay_Req message to the domainNumber field of the Delay_Resp message 6) Set the correctionField of the Delay_Resp message to 0 7) Add the correctionField of the Delay_Req message to the correctionField of the Delay_Resp message 8) Set the receiveTimestamp field of the Delay_Resp message to the seconds and nanoseconds portion of the time t_4 9) Subtract any fractional nanosecond portion of t_4 from the correctionField of the Delay_Resp message 10) Issue the Delay_Resp message IEEE-1588 Standard at p. 111. PTP uses a "port model" whereby "[t]he nodes in a PTP system interface with the network via entities called ports." *Id.* at pp.

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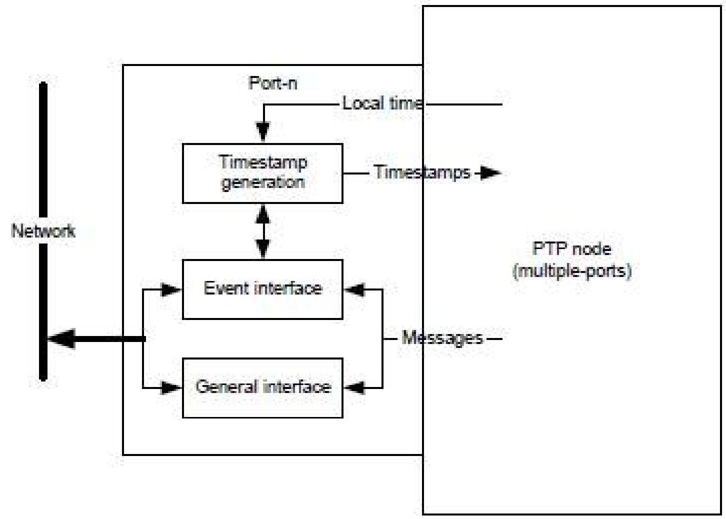
Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	47-48. The ports define the circuit.  **Figure 21—Port model** Each port on a PTP ordinary, boundary, or transparent clock is modeled as supporting two interfaces, event and general, as shown in Figure 21. The model shows that timestamps are generated for event messages (see 7.3.4.2) but are not required for general messages. NOTE—Figure 21 is a model. Unless otherwise stated in this standard, there is nothing precluding implementations that, for example, have a single interface, timestamp all messages, and sort out the event messages later. Each PTP port implements a single version of the protocol and uses a single transport protocol. More than one PTP port can connect to the network via a single physical port. The attributes of PTP ports are described in 7.5.2 to 7.5.5. *Id.* *See* claim 1.
Claim 5	

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
5. The method according to claim 4, further comprises the second time stamp associated with an overhead portion of the digital wrapping circuit.	In the Accused Products, the second time stamp is associated with an overhead portion of the digital wrapping circuit. As described above in connection with claims 1 and 4, the second timestamp is associated with the OSMC, which is contained within the overhead of the OTU. G.709 specifies a digital wrapping circuit for encapsulating an existing frame of data, regardless of the native protocol, to create an optical data unit (ODU) within an optical transport unit (OTU). *See* claim 4.
Claim 6	
[6.pre] A method, comprising:	*See* 1.pre above.
[6.a] generating a first time stamp associated with the first location;	*See* 1.a above. At least by sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the Accused Products generate a first time stamp associated with a first location (e.g. a slave clock at a first node)
[6.b] transmitting the first time stamp associated with the first location in a first overhead of a first optical transport unit frame to a second location via a network, wherein the first time stamp comprises information reflecting a round	*See* 1.b-1.d above. At least by sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the Accused Products transmit the first time stamp associated with a first location (e.g. a slave clock at a first node) to a second location (e.g. a master clock at a second node) via an optical transport network connecting these nodes.

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Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]**
trip delay of the network;	
[6.c] receiving a second time stamp associated with the second location in a second overhead of a second optical transport unit frame, wherein the second time stamp includes at least part of the information of the first time stamp extracted from the first overhead of the first optical transport unit frame; and	*See* 1.e-1.f above. At least by sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the Accused Products receive a second stamp associated with a first location (e.g. a master clock at a second node) at the first location (e.g. a slave clock at a first node) via an optical transport network connecting these nodes.
[6.d] processing the second time stamp associated with the second location to measure the round trip delay of the network.	*See* 1.g above. At least by sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the Accused Products process the second time stamp associated with the second location (e.g. a master clock at a second node) to measure the round trip delay of the network.
Claim 8	
8. The method according to claim 6,	In the Accused Products, transmitting the first time stamp associated with the first location comprises associating the first time stamp with the first location in a digital wrapping circuit.

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Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]**
wherein transmitting the first time stamp associated with the first location comprises associating the first time stamp with the first location in a digital wrapping circuit.	See claim 4.
Claim 9	
9. The method according to claim 8, further comprises associating the first time stamp with the first location in an overhead portion of the digital wrapping circuit.	The Accused Products associate the first time stamp with the first location in an overhead portion of the digital wrapping circuit. *See* claim 5.
Claim 10	
10. The method according to claim 6, wherein processing the second time stamp associated with the second location further	The Accused Products include the functionality of claim 6, wherein processing the second time stamp associated with the second location comprises determining the round trip delay of the network based at least in part on the second stamp associated with the second location. *See e.g.*, IEEE 1588 at 112:

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
comprises: determining the round trip delay of the network based at least in part on the second stamp associated with the second location.	d) Upon receipt of the Delay_Resp message by the slave: 1) If the received Sync message indicated that a Follow_Up message will not be received, the <meanPathDelay> shall be computed as: <meanPathDelay> = [(t_2 - t_3) + (receiveTimestamp of Delay_Resp message – originTimestamp of Sync message) – correctionField of Sync message – correctionField of Delay_Resp message]/2. 2) If the received Sync message indicated that a Follow_Up message will be received, the <meanPathDelay> shall be computed as: <meanPathDelay> = [(t_2 - t_3) + (receiveTimestamp of Delay_Resp message – preciseOriginTimestamp of Follow_Up message) – correctionField of Sync message– correctionField of Follow_Up message – correctionField of Delay_Resp message]/2. NOTE— The delay request-response path length measurement normally uses the timestamps and correctionField of the most recent Sync and corresponding Follow_Up message prior to the Delay_Req message. However, the delay request-response measurement may use any Sync and corresponding Follow_Up message, although this will reduce the accuracy of the computed <meanPathDelay>. *See* claim 1.
Claim 11	
11. The method according to claim 6, further comprises: synchronizing network elements at the first location and the second location.	The Accused Products include the functionality of claim 6, further comprising synchronizing network elements at the first location and the second location. For example, the slave clock at the first node will synchronize to the master clock at the second node, such that network elements at both first and second node are synchronized. *See e.g.* IEEE 1588 at 123: **12.2 Synchronization** Within a domain, an ordinary or boundary clock with a port in the Slave state shall synchronize to its master in the synchronization hierarchy established by the best master clock algorithm. The specific means for synchronization are out of the scope of this standard but shall result in the minimization of the <offsetFromMaster> value computed by the slave per 11.2. *See also id.* § 6 ("Clock synchronization model"):

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Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]**
	6.3 PTP systems A PTP system is a distributed, networked system consisting of a combination of PTP and non-PTP devices. PTP devices include ordinary clocks, boundary clocks, end-to-end transparent clocks, peer-to-peer transparent clocks, and management nodes. Non-PTP devices include bridges, routers, and other infrastructure devices, and possibly devices such as computers, printers, and other application devices. The protocol is a distributed protocol that specifies how the real-time clocks in the system synchronize with each other. These clocks are organized into a master–slave synchronization hierarchy with the clock at the top of the hierarchy—the grandmaster clock—determining the reference time for the entire system. The synchronization is achieved by exchanging PTP timing messages, with the slaves using the timing information to adjust their clocks to the time of their master in the hierarchy. *See* Claim 1.
Claim 12	
[12.pre] A system, comprising:	*See* claim 1.pre above. For example, each Accused Product is a system for synchronizing a clock or the time by implementing portions of G.709 Standard and the IEEE-1588 Standard over G.709 interfaces. Because each Accused Product performs the method of claim 1, each Accused Product comprises the necessary modules to carry out this method. For example, the OSN 1800 series implement the G.709 and the IEEE-1588 v2 standards:

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<table>
<tr><th>Asserted Claim (P.R. 3-1(a))</th><th>Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]</th></tr>
<tr><td></td><td>
<table>
<tr><td rowspan="3">OTN-Side</td><td>Interface Type</td><td>OTU-1/OTU-2 (ITU-T G.709)</td></tr>
<tr><td>Fiber Type</td><td>SMF (ITU-T G.652)/ DSF (ITU-T G.653)</td></tr>
<tr><td>Plug</td><td>SFP/XFP</td></tr>
<tr><td colspan="2">Topology</td><td>Point to point, chain, star, ring</td></tr>
<tr><td colspan="2">Synchronization</td><td>2Mbit/s or 2MHz, SSM supported
Ethernet Syn,1588V2</td></tr>
</table>
See http://www1.huawei.com/ucmf/groups/public/documents/webasset/hw_u_387741.pdf (last accessed Feb. 24, 2020).

As another example, the OSN 8800 series implements the same standards:
<table>
<tr><td>OTN service</td><td>OTU1, OTU2, OTU2e, OTU3</td><td>ITU-T G.709
ITU-T G.959.1</td></tr>
</table>
3.9 Clock Feature
OptiX OSN 8800 T32 and OptiX OSN 8800 T64 support the physical layer clock and PTP clock to realize the synchronization of the clock and the time.
The physical clock extracts the clock from the serial bit stream at the physical layer to realize the synchronization of the frequency.
The Precision Time Protocol (PTP) clock complies with the IEEE 1588 v2 protocol. IEEE 1588 v2 is a synchronization protocol, which realizes time synchronization based on the timestamp generated during the exchanging of protocol packets. It provides the nanosecond accuracy to meet the requirements of 3G base stations.
See https://www.actfornet.com/HUAWEI_TRANSPORT_DOCS/OptiX%20OSN%208800%20T16%20Product%20Overview.pdf (last accessed Apr. 27, 2020).
</td></tr>
<tr><td>[12.a] a receiving module to receive a first time stamp</td><td>See claim 1.a-1.b above.</td></tr>
</table>

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to Verizon's Preliminary Disclosure of Asserted Claims and Infringement Contentions (P.R. 3-1)
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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
associated with a first location inserted in a first overhead of a first optical transport unit frame at a second location	
[12.b] and extract information of the first time stamp from the first overhead of the first optical transport unit frame,	*See* claim 1.~~b~~c above.
[12.c] wherein the information of the first time stamp reflects a round trip delay of a network;	*See* claim 1.~~c~~d above.
[12.d] a processing module comprising a computer processor to store the information of the first time stamp from the first overhead of the first optical transport unit frame;	*See* claim 1.c-1.d above.
[12.e] a generating	*See* claim 1.e-1,f above.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
module to generate a second time stamp based at least in part on the extracted information of the first time stamp associated with the first location, wherein the second time stamp includes at least part of the extracted information of the first time stamp;	
[12.f] a transmission module to transmit the second time stamp in a second overhead of a second optical transport unit frame to the first location via the network to measure the round trip delay of the network.	*See* claim 1.~~f~~g above.
Claim 14	
14. The system according to claim 12, wherein the	In the Accused Products, the transmission module associates the second time stamp associated with the second location with a digital wrapping circuit.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
transmission module associates the second time stamp associated with the second location with a digital wrapping circuit.	*See* claim 4.
Claim 15	
15. The system according to claim 14, wherein the transmission module associates the second time stamp associated with the second location with an overhead portion of the digital wrapping circuit.	In the Accused Products, the transmission module associates the second time stamp associated with the second location with an overhead portion of the digital wrapping circuit. *See* claim 5.
Claim 16	
[16.pre] A system, comprising:	*See* claim ~~6.~~1.pre above.
[16.a] a generating module to generate a first time stamp associated with the first location;	*See* claim ~~6.~~1.a above.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
[16.b] a transmission module to transmit the first time stamp associated with the first location in a first overhead of a first optical transport unit frame to a second location via a network,	*See* claim ~~6.~~1.b-1.c above.
[16.c] wherein the first time stamp comprises information reflecting a round trip delay of the network;	*See* claim ~~6.c~~1.d above.
[16.d] a receiving module to receive a second time stamp inserted in a second overhead of a second optical transport unit frame associated with the second location,	*See* claim ~~6.d~~1.e above.
[16.e] wherein the second time stamp includes at least part	*See* claim ~~6.e~~1.f above.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
of information of the first time stamp extracted from the first overhead of the first optical transport unit frame; and	
[16.f] a processing module comprising a computer processor to process the second time stamp associated with the second location to measure the round trip delay of the network.	*See* claim ~~6.f~~1.c-1.d above.
Claim 18	
18. The system according to claim 16, wherein the transmission module associates the first time stamp associated with the first location with a digital wrapping circuit.	In the Accused Products, the transmission module associates the first time stamp associated with the first location with a digital wrapping circuit. *See* claim 4.
Claim 19	

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Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]**
19. The system according to claim 18, wherein the transmission module associates the first time stamp associated with the first location with an overhead portion of the digital wrapping circuit.	In the Accused Products, the transmission module associates the first time stamp associated with the first location with an overhead portion of the digital wrapping circuit. *See* claim 5.
Claim 20	
20. The system according to claim 16, wherein the processing module calculates the round trip delay of the network based at least in part on the second time stamp associated with the second location.	In the Accused Products, the processing module calculates the round trip delay of the network based at least in part on the second time stamp associated with the second location. *See* claim 10.
Claim 21	
21. The system according to claim 16, wherein the network elements at	In the Accused Products, the network elements at the first location and the second location are synchronized. *See* claim 11.

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Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]**
the first location and the second location are synchronized.	
Claim 22	
[22.pre] A method, comprising:	*See* 1.pre and 6.pre above.
[22.a] generating a first time stamp associated with the first location;	*See* 1.a and 6.a above. By sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the Accused Products generate a first time stamp associated with a first location (e.g. a slave clock at a first node).
[22.b] transmitting the first time stamp associated with the first location in a first overhead of a first optical transport unit frame to a second location via a network,	*See* ~~6.b~~1.a-1.c above. By sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the Accused Products transmit the first time stamp associated with the first location (e.g. a slave clock at a first node) to a second location (e.g. a master clock at a second node).
[22.c] wherein the first time stamp comprises information reflecting a round trip delay of the network;	*See* ~~6.b~~1.d above.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
[22.d] receiving a first time stamp associated with a first location at a second location;	*See* 1.a above.
[22.e] extracting information of the first time stamp from the first overhead of the first optical transport unit frame;	*See* 1.c above.
[22.f] generating a second time stamp based at least in part on the extracted information of the first time stamp associated with the first location,	*See* 1.~~d~~e above. By sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the Accused Products generate a second time stamp associated with the second location (e.g. a master clock at a second node), based in part on extracted information from the first time stamp associated with the first location (e.g. a slave clock at a first node).
[22.g] wherein the second time stamp includes at least part of the extracted information of the first time stamp;	*See* 1.~~d~~f above.
[22.h] transmitting the second time stamp in a second	*See* 1.~~e~~g above. By sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the

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Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]**
overhead of a second optical transport unit frame to the first location;	Accused Products transmit the second time stamp associated with the second location (e.g. a master clock at a second node), to the first location (e.g. a slave clock at a first node).
[22.i] receiving a second time stamp associated with the second location at the first location; and	*See* 6.~~e~~g above. By sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the Accused Products receive the second time stamp associated with the second location (e.g. a master clock at a second node) at the first location (e.g. a slave clock at a first node).
[22.j] processing the second time stamp associated with the second location to measure the round trip delay of the network.	*See* 6.~~d~~g above.
Claim 23	
23. A non-transitory computer readable storage media comprising code to perform the acts of the method of claim 1.	The Accused Products comprise non-transitory computer readable storage media comprising code to perform the acts of the method of claim 1. The Accused Products practice a method for synchronizing a clock or the time by implementing portions of the G.709 Standard and the IEEE-1588 Standard over G.709 interfaces – the implementation is carried out by code stored on the non-transitory computer readable storage media. For example, the OSN 1800 series implement the G.709 and the IEEE-1588 v2 Standards:

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	<table><tr><td rowspan="3">OTN-Side</td><td>Interface Type</td><td>OTU-1/OTU-2 (ITU-T G.709)</td></tr><tr><td>Fiber Type</td><td>SMF (ITU-T G.652)/ DSF (ITU-T G.653)</td></tr><tr><td>Plug</td><td>SFP/XFP</td></tr><tr><td colspan="2">Topology</td><td>Point to point, chain, star, ring</td></tr><tr><td colspan="2">Synchronization</td><td>2Mbit/s or 2MHz, SSM supported Ethernet Syn,1588V2</td></tr></table> *See http://www1.huawei.com/ucmf/groups/public/documents/webasset/hw_u_387741.pdf* (last accessed Feb. 24, 2020). As another example, the OSN 8800 series implements the same standards: <table><tr><td>OTN service</td><td>OTU1, OTU2, OTU2e, OTU3</td><td>ITU-T G.709 ITU-T G.959.1</td></tr></table> **3.9 Clock Feature** OptiX OSN 8800 T32 and OptiX OSN 8800 T64 support the physical layer clock and PTP clock to realize the synchronization of the clock and the time. The physical clock extracts the clock from the serial bit stream at the physical layer to realize the synchronization of the frequency. The Precision Time Protocol (PTP) clock complies with the IEEE 1588 v2 protocol. IEEE 1588 v2 is a synchronization protocol, which realizes time synchronization based on the timestamp generated during the exchanging of protocol packets. It provides the nanosecond accuracy to meet the requirements of 3G base stations. *See https://www.actfornet.com/HUAWEI_TRANSPORT_DOCS/OptiX%20OSN%208800%20T16%20Product%20Overview.pdf* (last accessed Apr. 27, 2020). *See* Claim 1.
Claim 24	

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Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]**
24. A non-transitory computer readable storage media comprising code to perform the acts of the method of claim 6.	*See* claims 23 and 6 above.
Claim 25	
25. A non-transitory computer readable storage media comprising code to perform the acts of the method of claim 22.	*See* claims 23 and 22 above.
Claim 26	
[26.pre] A method, comprising:	*See* 1.pre above.
[26.a] receiving a first time stamp associated with a first location in a first overhead of a first optical transport unit frame at a second location during a first data	*See* 1.a and 1.b above.

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
transmission;	
[26.b] extracting information of the first time stamp from the first overhead of the first optical transport unit frame,	*See* 1.~~b~~c above.
[26.c] wherein the information reflects a round trip delay of a network;	*See* 1.~~c~~d above.
[26.d] generating a second time stamp based at least in part on the extracted information of the first time stamp associated with the first location,	*See* 1.~~d~~e above.
[26.e] wherein the second time stamp includes at least part of the extracted information of the first time stamp; and	*See* 1.~~e~~f above.
[26.f] transmitting the second time	*See* 1.~~f~~g above.

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Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]**
stamp in a second overhead of a second optical transport unit frame to the first location during a second data transmission	
[26.g] wherein the second time stamp is used to measure the round trip delay of the network.	*See* 1.~~e~~g above.
Claim 27	
27. The method according to claim 26, wherein the first data transmission comprises transmitting a first data packet wherein the first data packet comprises the first time stamp.	The Accused Products transmit a first data packet wherein the first data packet comprises the first time stamp. For example, the Accused Products transmit a Delay_Req message that includes the first timestamp. At least by sending and receiving PTP messages using the OTU overhead (*e.g.*, PTP event messages such as a delay request), the Accused Products transmit the Delay_Req message from the first location (e.g. a slave clock at a first node) to a second location (e.g. a master clock at a second node), and the Delay_Req message is a data packet comprising a header with a "correctionField" and an "originTimestamp," as described above. *See e.g.*:

Exhibit 111
to Verizon's Preliminary Disclosure of Asserted Claims and Infringement Contentions (P.R. 3-1)
U.S. Patent No. 8,121,111

<table>
<tr><th>Asserted Claim (P.R. 3-1(a))</th><th>Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]</th></tr>
<tr><td></td><td>

13.6 Sync and Delay_Req messages

13.6.1 General Sync and Delay_Req message specifications

The fields of Sync and Delay_Req messages shall be as specified in Table 26.

Table 26—Sync and Delay_Req message fields

Bits								Octets	Offset
7	6	5	4	3	2	1	0		
header (see 13.3)								34	0
originTimestamp								10	34

IEEE-1588 Standard at p. 130.

See claim 1.

</td></tr>
<tr><td>Claim 28</td><td></td></tr>
<tr><td>28. The method according to claim 26, wherein the second data transmission comprises transmitting a second data packet wherein the second data packet comprises the second time stamp.</td><td>At least by sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a Delay Request), the Accused Products transmit the Delay_Resp message from the second location (e.g. a master clock at a second node) to a first location (e.g. a slave clock at a first node), and the Delay_Resp message is a data packet comprising a header (with a correctionField) and a receiveTimestamp. See e.g.:</td></tr>
</table>

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
	13.8 Delay_Resp message **13.8.1 General Delay_Resp message specifications** The fields of the Delay_Resp message shall be as specified in Table 28. **Table 28—Delay_Resp message fields** Bits (7 6 5 4 3 2 1 0) | Octets | Offset header (see 13.3) | 34 | 0 receiveTimestamp | 10 | 34 requestingPortIdentity | 10 | 44 IEEE-1588 Standard at p. 130. *See* claim 1.
Claim 29	
29. The method according to claim 26, wherein the second time stamp is embedded in an overhead portion of a digital wrapping circuit.	In the Accused products, the second time stamp is embedded in an overhead portion of a digital wrapping circuit. *See* claim 5.
Claim 30	

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<table>
<tr><th>Asserted Claim (P.R. 3-1(a))</th><th>Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]</th></tr>
<tr><td>[30.pre] A method, comprising:</td><td>See ~~12.~~1.pre above.</td></tr>
<tr><td>[30.a] generating a first time stamp associated with the first location;</td><td>See ~~12.~~1.a above.</td></tr>
<tr><td>[30.b] transmitting the first time stamp associated with the first location in a first overhead of a first optical transport unit frame to a second location during a first data transmission via a network,</td><td>See ~~12.b above, see 26.b~~1.a-1.c above.

By sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the Accused Products transmit data, e.g. the Delay_Req message from the first location (e.g. a slave clock at a first node) to a second location (e.g. a master clock at a second node), and the Delay_Req message is a data packet comprising an origin Timestamp. See e.g.:

13.6 Sync and Delay_Req messages

13.6.1 General Sync and Delay_Req message specifications
The fields of Sync and Delay_Req messages shall be as specified in Table 26.

Table 26—Sync and Delay_Req message fields
<table>
<tr><th colspan="8">Bits</th><th rowspan="2">Octets</th><th rowspan="2">Offset</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td colspan="8">header (see 13.3)</td><td>34</td><td>0</td></tr>
<tr><td colspan="8">originTimestamp</td><td>10</td><td>34</td></tr>
</table>

IEEE-1588 Standard at p. 130.</td></tr>
<tr><td>[30.c] wherein the</td><td>See ~~12.c~~1.d above.</td></tr>
</table>

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Asserted Claim (P.R. 3-1(a))	Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]
first time stamp comprises information reflecting a round trip delay of the network;	
[30.d] receiving a second time stamp associated with the second location in a second overhead of a second transport unit frame during a second data transmission,	*See* ~~12.d~~1.e-1.g above. By sending and receiving PTP messages using the OTU overhead, (e.g. PTP event messages such as a delay request), the Accused Products transmit data, e.g. the Delay_Resp message from the second location (e.g. a master clock at a second node) to a first location (e.g. a salve clock at a first node), and the Delay_Resp message is a data packet comprising a receiveTimestamp. *See e.g.*: **13.8 Delay_Resp message** **13.8.1 General Delay_Resp message specifications** The fields of the Delay_Resp message shall be as specified in Table 28. **Table 28—Delay_Resp message fields** Bits (7 6 5 4 3 2 1 0) | Octets | Offset header (see 13.3) | 34 | 0 receiveTimestamp | 10 | 34 requestingPortIdentity | 10 | 44 IEEE-1588 Standard at p. 130.
[30.e] wherein the second time stamp	*See* ~~12.e~~1.f above.

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Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]**
includes at least part of information of the first time stamp extracted from the first overhead of the first transport unit frame; and	
[30.f] processing the second time stamp associated with the second location to measure a round trip delay of the network.	*See* ~~12.f~~1.g above.
Claim 31	
31. The method according to claim 30, wherein the first data transmission comprises transmitting a first data packet wherein the first data packet comprises the first time stamp.	*See* claim 27 above.
Claim 32	

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Asserted Claim (P.R. 3-1(a))	**Accused Instrumentalities (P.R. 3-1(b)-(d)) And Where Each Claim Element is Found[2]**
32. The method according to claim 30, wherein the second data transmission comprises transmitting a second data packet wherein the second data packet comprises the second time stamp.	*See* claim 28 above.
Claim 33	
33. The method according to claim 30, wherein the first time stamp is embedded in an overhead portion of a digital wrapping circuit.	In the Accused Products, wherein the first time stamp is embedded in an overhead portion of a digital wrapping circuit. *See* claim 5.